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[研究文章 Research Article]

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A Preliminary Faunistic Survey of Carabidae (Coleoptera) from Gaomei Wetlands Wildlife Refuge, Taichung City, Taiwan

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Abstract: A systematic survey of ground beetles (Coleoptera: Carabidae) was conducted at Gaomei Wetlands Wildlife Refuge. We discovered 19 carabid species in the study area and provide a complete list of them. Among four sampling sites, the northern side of the Dajia River estuary had the highest species richness, where 14 species of Carabidae were recorded. The species compositions were also different across sampling sites, probably caused by habitat heterogeneity in Gaomei Wetlands Wildlife Refuge. In addition, we provide notes on the two most abundant species. *Bembidion foochowense* Lindroth 1980 is rediscovered and represents the first recorded littoral ground beetle in central Taiwan. *Mastax brittoni* Quentin, 1952, the species with three different elytral color patterns but has a constant elytral color pattern in our survey and occurs sympatrically with ants. Our investigation was focussed on the carabid fauna of central Taiwan and implied the insufficient investigation of littoral ground beetles.

Keywords: Ocean-shore ground beetles, *Desarmatocillenus*, Dajia River's estuary

Introduction

Ground beetles (Carabidae) form a large family in Coleoptera and consist of over 40,000 species worldwide (Erwin, 1985; Lövei & Sunderland, 1996). More than 400 species have been recorded in Taiwan, but the total carabid fauna of the country is still unclear (Terada et al., 2005; Terada, 2006). The species composition and richness of carabid beetles are important bioindicators in assessing environment or biodiversity (Rainio & Niemelä, 2003). Therefore, the systematic investigation of local fauna is important and informative to make the database of Taiwan carabid fauna more complete.

The Gaomei Wetlands Wildlife Refuge is a tidal-dominated coastal wetland connected to the south of Dajia River estuary (Hsu et al., 2020). The habitat composition includes five types: tidal creek, swampland, sand, gravel, and grassland areas (Wu & Huang, 2013). The habitat diversity is suitable for different carabid faunas (Lövei & Sunderland, 1996; Rainio & Niemelä, 2003); however, *Tachys fumicatus* (Motschulsky, 1851) was the only carabid recorded so far in Gaomei Wetlands Wildlife Refuge (Terada et al., 2013).

In order to confirm and update the ground beetle diversity of Gaomei Wetlands Wildlife Refuge, we conducted a systematic faunistic survey of carabid from March to December in 2020. During this survey, we collected 19 species belonging to five subfamilies of Carabidae. In this article, we provide a species list of Carabidae of Gaomei Wetlands Wildlife Refuge.

Materials and methods

We selected four sites that represent different habitats and vegetation in Gaomei Wetlands Wildlife Refuge (Fig. 1A): the northern side of Dajia river estuary (site A; Fig. 1B), the southern side of Dajia river estuary (site B; Fig. 1C), the swampland with *Phragmites australis* (Cav.) Trin. ex Steud. near Huan-á-liâu sea wall (site C; Fig. 1D), and the swampland with *Sporobolus virginicus* (L.) Kunth and *Zoysia sinica* Hance near Gaomei number 2 sea wall (site D; Fig. 1E).

Collection methods included drift-fence funnel trapping, light trapping and hand collection from March to December in 2020. We set one drift-fence funnel trap in each site. For each set of the drift-fence funnel traps, three or two plastic plates (100 cm × 30 cm) were connected together and set up vertically on the ground. Two plastic funnel traps (12.5 cm diameter, 36 cm length) without bait were set at both ends of the plastic plate to become an I-shape. We checked each drift-fence funnel trap one week per month. The light traps were set up with 40W HID light bulb (4300K color temperature). We conducted the light trapping at each collection

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site for 3 hours during the low tide period (about 18:00 p.m. − 21:00 p.m. according to the tide) in April and September. The hand collection was conducted for one hour at nighttime by one person per month.

Specimens were examined with a SMN 800N stereomicroscope and identified to species level by the first and the second authors. All specimens which examined in this study were deposited at National Museum of Natural Science, Taichung, Taiwan.

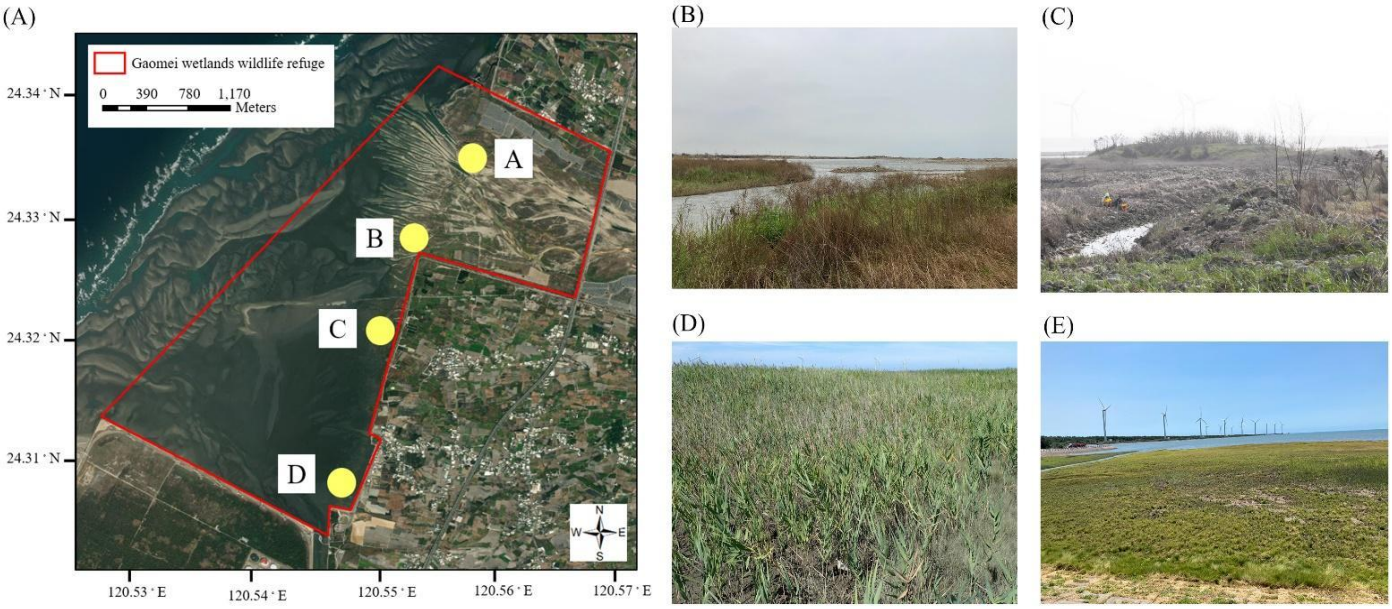

Figure 1. (A) Sampling sites of ground beetles in Gaomei Wetlands Wildlife Refuge, Taichung City, Taiwan. The habitat of (B) the northern side of Dajia estuary (site A), (C) southern side of Dajia estuary (site B), (D) Huan-á-liâu (番仔寮) sea wall (site C) and (E) Gaomei (高美) number 2 sea wall (site D).

Results

A total of 203 specimens belonging to 19 species of ground beetles were obtained from our survey in Gaomei Wetlands Wildlife Refuge. The drift-fence funnel trapping, light trapping and hand collection method collected 4, 8 and 11 species, respectively. A total of four species, *Calomera angulata* Fabricius, 1798, *Bembidion* (*Desarmatocillenus*) *foochowense* Lindroth, 1980, *Bembidion* (*Trichoplataphus*) *taiwanum* Netolitzky, 1939 and *Anchomenus leucopus* (Bates, 1873), were collected from hand collection and light trapping. *Pheropsophus* (*Stenaptinus*) *javanus* (Dejean, 1825) was collected from hand collection and drift-fence funnel trapping (Table 1). Three of the most abundant species were *B.* (*D.*) *foochowense* (n = 48), *Mastax brittoni* Quentin, 1952 (n = 30), and *B.* (*T.*) *taiwanum* (n = 27; Table 1). The most carabid-abundant site in this area is the northern side of Dajia River estuary (site A), where 14 species were recorded (Table 1). No ground beetle was obtained at the site of Gaomei number 2 sea wall (site D) (Table 1). Four species were obtained from the southern side of Dajia River estuary and Huan-á-liâu sea wall, respectively (Table 1). Most species only occurred in a single site, while a few species were found in two different sites, such as *Galerita orientalis* Schmidt-Gobel, 1846 and *P.* (*S.*) *javanus* occurred on both sides of the Dajia River estuary, and the *Callytron inspeculare inspeculare* Horn, 1904 occurred in the southern side of the Dajia River estuary and Huan-á-liâu sea wall site.

Discussion

Our survey revealed different species richness among sites. The hand collection is the most efficient method of collecting ground beetles in Gaomei Wetlands Wildlife Refuge; however, most species were collected by the single method in a single site (Table 1). No ground beetle was obtained in the Gaomei number 2 sea wall site from our survey (Table 1), in spite of the fact that there was a record of *Tachys fumicatus* from the same place (Terada et al., 2013). This site was frequently flooded by tide, hence this habitat is perhaps no longer suitable for carabid beetles. However, the Huan-á-liâu sea wall site is also a swampland and frequently flooded by tide but had ground beetles have occurred. We suggest the high grass vegetation of *Phragmites australis* in Huan-á-liâu sea wall site provides refuges for the full wings ground beetles, such as *Stenolophus* (*Egadroma*) *quinquepustulatus* (Wiedemann, 1823) and *Stenolophus* (*Egadroma*) *smaragdulus* (Fabricius, 1798). Although both sides of the Dajia River estuary have similar habitats in vegetation and landscape, the ground beetle compositions, species richness and abundance were different between the two sites (Table 1). For example, the highest species abundance which belongs to *Bembidion* group and *Chlaenius* group occurred only on northern side of the Dajia River estuary. It is not clear why these two sides had different species compositions;

however, the frequent flooding, erosion, and sedimentation in raining season which caused frequent habitat changing and microenvironmental difference perhaps one of the reasons. It should have further study to confirm what caused the different species compositions. Overall, our survey indicated that the ground beetle richness and compositions among sites likely associated with the habitat heterogeneity in Gaomei Wetlands Wildlife Refuge.

We provide an ecological note and discussions of the two most abundant species, *B.* (*D.*) *foochowense* and *Mastax brittoni* Quentin, 1952. *B.* (*D.*) *foochowense* is a littoral (seashore-dwelling) ground beetle (Fig. 2D) which lives in intertidal habitat and distributed in China, Hong Kong and Taiwan (Marggi et al., 2017). The first collection record of this species in Taiwan was from Fulong, northern Taiwan in 2008 (Toledano, 2009). Our finding is the first record in central Taiwan and the second record after a decade of the first record in Taiwan. This result implies the insufficient investigation of Taiwan carabid fauna and a much wider potential distribution of *B. foochowense* in river estuaries of Taiwan.

Mastax brittoni has three different elytral color patterns (Terada & Wu, 2018). The Gaomei population consists of only one pattern, which has two dull-orange anterior spots and a whitish posterior spot on each elytron (Fig. 2R). It is interesting that the elytral pattern of *M. brittoni* is almost constant of all specimens from Gaomei Wetlands Wildlife Refuge because it was not clear that these three elytral patterns are inter- or intrapopulation variations. Our finding is perhaps an evidence that these three elytral patterns are interpopulation variations; however, it still needs more investigation survey of other geological populations to confirm our inference. In our result, thirty individuals of *M. brittoni* were all collected from the southern side of Dajia River estuary (Fig. 1B), and no individuals from the other three collection sites (Table 1). Those specimens were found in a dry-out puddle with moist sandy substrate covered with some gravel, where we also observed a certain ant species (*Paratrechina* sp.) was sympatric with them. Although these two species appeared in the same habitat, no interaction was observed between them.

Species list of Gaomei Wetlands Wildlife Refuge

(Based on our collection in 2020)

Cicindelinae Latreille, 1802

Cicindelini Latreille, 1802

1. *Callytron inspeculare inspeculare* Horn, 1904 暗色白緣虎甲蟲 (Fig. 2A)

Material examined. TAIWAN: 1♀1♂, Taichung City, southern side of Dajia estuary, 24.327003N 120.553611E, hand collection, 03. VI. 2020, L.-W. Yeh leg.; 1♀, Taichung City, Huan-á-liâu sea wall, 24.324441N 120.553119E, hand collection, 03. VI. 2020, L.-W. Yeh leg.; 2♂, Taichung City, Huan-á-liâu sea wall, 24.318281N 120.550611E, hand collection, 22. IX. 2020, L.-W. Yeh leg.

2. *Calomera angulata* Fabricius, 1798 白紋虎甲蟲 (Fig. 2B)

Material examined. TAIWAN: 4♀♀1♂, Taichung City, northern side of Dajia estuary, 24.334310N 120.558642E, hand collection, 29. IV. 2020, L.-W. Yeh leg.; 1♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 03. VI. 2020, L.-W. Yeh leg.; 1♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 05. VI. 2020, L.-W. Yeh leg.; 2♂♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 23. IX. 2020, L.-W. Yeh leg.; 3♀♀5♂♂, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.

3. *Cylindera* (*Eugrapha*) *elisae formosana* Minowa, 1932 臺灣虎甲蟲; 蓬萊虎甲蟲 (Fig. 2C)

Material examined. TAIWAN: 3♀♀4♂♂, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.

Trechinae Bonelli, 1810

Bembidiini Stephens, 1827

4. *Bembidion* (*Desarmatocillenus*) *foochowense* Lindroth, 1980 (Fig. 2D)

Material examined. TAIWAN: 14♀♀19♂♂, Taichung City, northern side of Dajia estuary, 24.334678N 120.556376E, hand collection, 24. IV. 2020, L.-W. Yeh leg.; 6♀♀3♂♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 23. IX. 2020, L.-W. Yeh leg.; 1♂, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.; 2♀♀3♂♂, Taichung City, northern side of Dajia estuary, 24.334678N 120.556376E, hand collection, 26. X. 2020, L.-W. Yeh leg.

5. *Bembidion* (*Notaphocampa*) *niloticum batesi* Putzeys, 1875 (Fig. 2E)

Material examined. TAIWAN: 2♂♂, Taichung City, northern side of Dajia estuary, 24.334527N 120.556774E, hand collection, 22. VII. 2020, L.-W. Yeh leg.; 2♂♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 23. IX. 2020, L.-W. Yeh leg.

6. *Bembidion* (*Odontium*) *gebieni* Netolitzky, 1928 (Fig. 2F)

Material examined. TAIWAN: 3♀♀1♂, Taichung City, northern side of Dajia estuary, 24.333499N 120.558756E, hand collection, 05. VI. 2020, L.-W. Yeh leg.

7. *Bembidion* (*Trichoplataphus*) *taiwanum* Netolitzky, 1939 (Fig. 2G)

Material examined. TAIWAN: 1♀2♂♂, Taichung City, northern side of Dajia estuary, 24.334238N 120.559111E, hand collection, 21. IX. 2020, L.-W. Yeh leg.; 9♀♀7♂♂, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.; 7♀♀1♂, Taichung City, northern side of Dajia estuary, 24.333500N 120.561086E, hand collection, 21. X. 2020, L.-W. Yeh leg.

Harpalinae Bonelli, 1810

Chlaeniini Brullé, 1834

8. *Chlaenius* (*Amblygenius*) *touzalini* Andrewes, 1920 (Fig. 2H)

Material examined. TAIWAN: 1♀, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 29. IV. 2020, L.-W. Yeh leg.; 1♂, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 05. VI. 2020, L.-W. Yeh leg.; 2♂♂, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 07. VI. 2020, L.-W. Yeh leg.

9. *Chlaenius* (*Chlaeniellus*) *inops inops* Chaudoir, 1856 (Fig. 2I)

Material examined. TAIWAN: 2♀♀, Taichung City, northern side of Dajia estuary, 24.334288N 120.558867E, hand collection, 21. IV. 2020, L.-W. Yeh leg.; 4♀♀8♂♂, Taichung City, northern side of Dajia estuary, 24.334288N 120.558867E, hand collection, 21. X. 2020, L.-W. Yeh leg.

10. *Chlaenius* (*Chlaeniostenus*) *circumdatus xanthopleurus* (Chaudoir, 1856) (Fig. 2J)

Material examined. TAIWAN: 2♀♀3♂♂, Taichung City, northern side of Dajia estuary, 24.334288N 120.558867E, hand collection, 21. X. 2020, L.-W. Yeh leg.

11. *Chlaenius* (*Lithochlaenius*) *rambouseki* Lutshnik, 1933 (Fig. 2K)

Material examined. TAIWAN: 1♂, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.

Galeritini Kirby 1825

12. *Galerita orientalis* Schmidt-Gobel, 1846 (Fig. 2L)

Material examined. TAIWAN: 1♂, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 13. III. 2020, L.-W. Yeh leg.; 1♀2♂♂, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 13. III. 2020, L.-W. Yeh leg.; 2♀♀1♂, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 29. IV. 2020, L.-W. Yeh leg.; 1♂, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 05. VI. 2020, L.-W. Yeh leg.; 3♀♀, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 07. VI. 2020, L.-W. Yeh leg.; 1♀, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 23. IX. 2020, L.-W. Yeh leg.

Harpalini Bonelli, 1810

13. *Acupalpus* (*Stenolophidius*) *inornatus* Bates, 1873 (Fig. 2M)

Material examined. TAIWAN: 2♀♀1♂, Taichung City, Huan-á-liâu sea wall, 24.322278N 120.552676E, light trap, 25. IV. 2020, L.-W. Yeh leg.

14. *Stenolophus* (*Egadroma*) *quinquepustulatus* (Wiedemann, 1823) (Fig. 2N)

Material examined. TAIWAN: 3♀♀5♂♂, Taichung City, Huan-á-liâu sea wall, 24.322278N 120.552676E, light trap, 25. IV. 2020, L.-W. Yeh leg.

15. *Stenolophus* (*Egadroma*) *smaragdulus* (Fabricius, 1798) (Fig. 2O)

Material examined. TAIWAN: 2♂♂, Taichung City, Huan-á-liâu sea wall, 24.322278N 120.552676E, light trap, 25. IV. 2020, L.-W. Yeh leg.

Panagaeini Bonelli, 1810

16. *Craspedophorus mandarinus* (Schaum, 1854) 寬四星步行蟲 (Fig. 2P)

Material examined. TAIWAN: 1♀, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 29. IV. 2020, L.-W. Yeh leg.

Platynini Bonelli, 1810

17. *Anchomenus leucopus* (Bates, 1873) (Fig. 2Q)
Material examined. TAIWAN: 1♀, Taichung City, northern side of Dajia estuary, 24.334475N 120.557875E, light trap, 23. IX. 2020, L.-W. Yeh leg.; 1♀1♂, Taichung City, northern side of Dajia estuary, 24.334288N 120.558867E, hand collection, 21. X. 2020, L.-W. Yeh leg.

Brachininae Bonelli, 1810
Brachinini Bonelli, 1810

18. *Mastax brittoni* Quentin, 1952 (Fig. 2R)
Material examined. TAIWAN: 19♀♀11♂♂, Taichung City, southern side of Dajia estuary, 24.328201N 120.558788E, hand collection, 18. XI. 2020, L.-W. Yeh leg.

19. *Pheropsophus* (*Stenaptinus*) *javanus* (Dejean, 1825) 黃紋放屁蟲 (Fig. 2S)
Material examined. TAIWAN: 1♀, Taichung City, southern side of Dajia estuary, 24.326734N 120.552198E hand collection, 25. IV. 2020, L.-W. Yeh leg.; 1♀2♂♂, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 29. IV. 2020, L.-W. Yeh leg.; 2♂♂, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 05. VI. 2020, L.-W. Yeh leg.; 1♂, Taichung City, northern side of Dajia estuary, 24.334529N 120.558082E, drift-fence funnel trap, 07. VI. 2020, L.-W. Yeh leg.; 1♀, Taichung City, southern side of Dajia estuary, 24.327490N 120.559409E, drift-fence funnel trap, 23. IX. 2020, L.-W. Yeh leg.

Table 1. Species composition of Carabidae and collection methods in four sites of Gaomei Wetlands Wildlife Refuge. The abbreviations of H, L and D were hand collection, light trapping and drift-fence funnel trapping, respectively. The number in the parentheses represents the individuals of collection method.

Species	Number of individuals	Northern side of Dajia estuary	Southern side of Dajia estuary	Huan-á-liâu sea wall	Gaomei number 2 sea wall
1. *Callytron inspeculare inspeculare*	5		H (2)	H (3)	
2. *Calomera angulata*	17	H (9), L (8)			
3. *Cylindera* (*Eugrapha*) *elisae formosana*	7	L (7)			
4. *Bembidion* (*Desarmatocillenus*) *foochowense*	48	H (47), L (1)			
5. *B.* (*Notaphocampa*) *niloticum batesi*	4	H (4)			
6. *B.* (*Odontium*) *gebieni*	4	H (4)			
7. *B.* (*Trichoplataphus*) *taiwanum*	27	H (11), L (16)			
8. *Chlaenius* (*Amblygenius*) *touzalini*	4	D (4)			
9. *C.* (*Chlaeniellus*) *inops inops*	14	H (14)			
10. *C.* (*Chlaeniostenus*) *circumdatus xanthopleurus*	5	H (5)			
11. *C.* (*Lithochlaenius*) *rambouseki*	1	L (1)			
12. *Galerita orientalis*	12	D (9)	D (3)		
13. *Acupalpus* (*Stenolophidius*) *inornatus*	3			L (3)	
14. *Stenolophus* (*Egadroma*) *quinquepustulatus*	8			L (8)	
15. *S.* (*Egadroma*) *smaragdulus*	2			L (2)	
16. *Craspedophorus mandarinus*	1	D (1)			
17. *Anchomenus leucopus*	3	H (2), L (1)			
18. *Mastax brittoni*	30		H (30)		
19. *Pheropsophus* (*Stenaptinus*) *javanus*	8	D (1)	D (6), H (1)		
Total of species		14	4	4	0

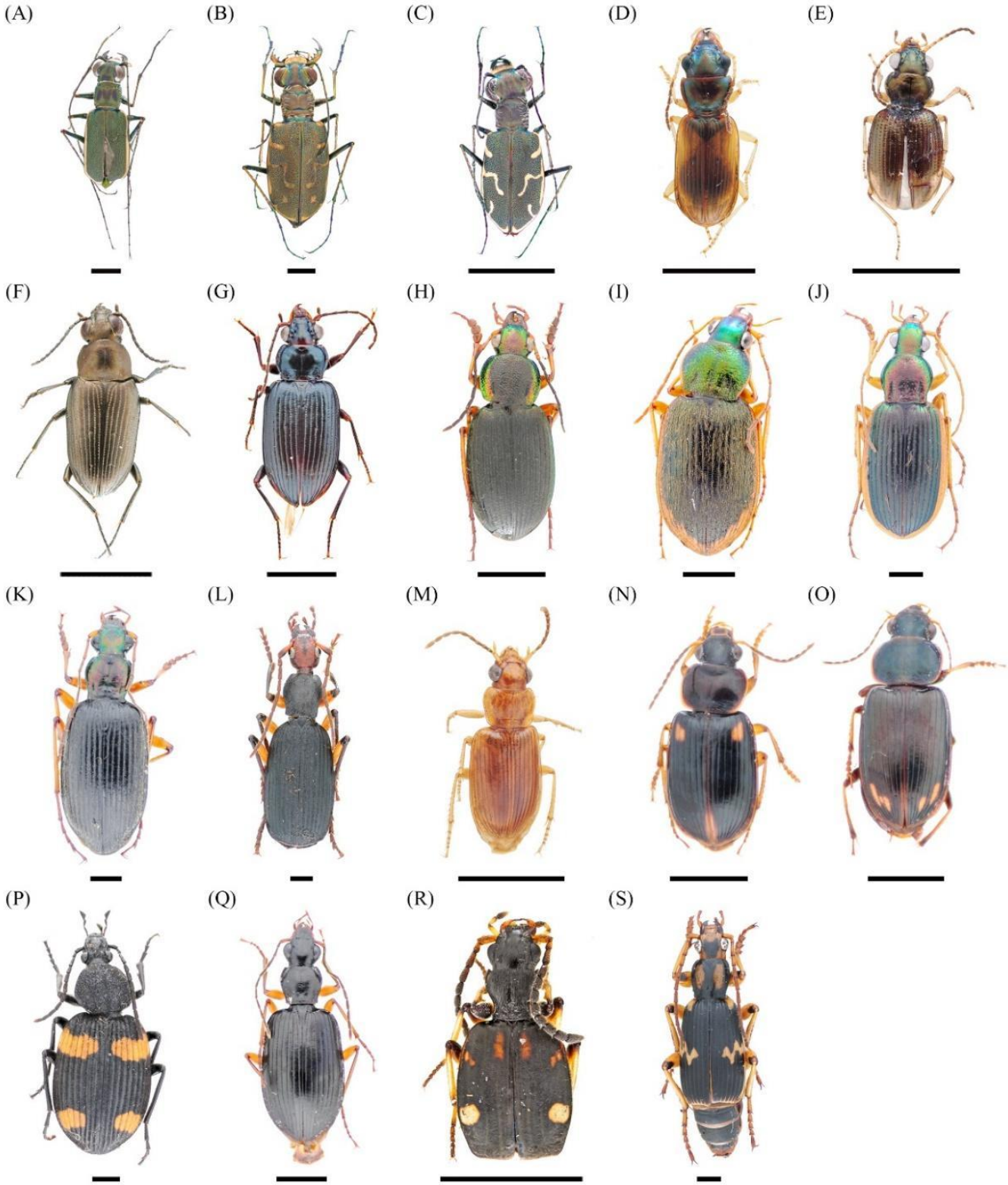

Figure 2. Habitus of (A) *Callytron inspeculare inspeculare* Horn, 1904; (B) *Calomera angulata* Fabricius, 1798; (C) *Cylindera* (*Eugrapha*) *elisae formosana* Minowa, 1932; (D) *Bembidion* (*Desarmatocillenus*) *foochowense* Lindroth, 1980; (E) *Bembidion* (*Notaphocampa*) *niloticum batesi* Putzeys, 1875; (F) *Bembidion* (*Odontium*) *gebieni* Netolitzky, 1928; (G) *Bembidion* (*Trichoplataphus*) *taiwanum* Netolitzky, 1939; (H) *Chlaenius* (*Amblygenius*) *touzalini* Andrewes, 1920; (I) *Chlaenius* (*Chlaeniellus*) *inops inops* Chaudoir, 1856; (J) *Chlaenius* (*Chlaeniostenus*) *circumdatus xanthopleurus* (Chaudoir, 1856); (K) *Chlaenius* (*Lithochlaenius*) *rambouseki* Lutshnik, 1933; (L) *Galerita orientalis* Schmidt-Gobel, 1846; (M) *Acupalpus* (*Stenolophidius*) *inornatus* Bates, 1873; (N) *Stenolophus* (*Egadroma*) *quinquepustulatus* (Wiedemann, 1823); (O) *Stenolophus* (*Egadroma*) *smaragdulus* (Fabricius, 1798); (P) *Craspedophorus mandarinus* (Schaum, 1854); (Q) *Anchomenus leucopus* (Bates, 1873); (R) *Mastax brittoni* Quentin, 1952; and (S) *Pheropsophus* (*Stenaptinus*) *javanus* (Dejean, 1825) on Gaomei Wetlands Wildlife Refuge. The scale bars are 2 mm.

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台中市高美野生動物保護區步行蟲科（鞘翅目）調查初探

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摘要: 我們在 2020 年針對台中高美野生動物保護區進行系統性的步行蟲調查，在 4 個不同類型的棲地共記錄 19 種步行蟲。大甲溪北岸的樣點多樣性最高，共記錄 14 種步行蟲。本文提供兩種最優勢的步行蟲的相關生態資訊。*Bembidion foochowense* Lindroth, 1980 為臺灣的第二筆紀錄，也是首次於臺灣中部發現的潮間帶步行蟲。*Mastax brittoni* Quentin, 1952 曾記錄三種不同的翅鞘斑紋，但於高美野生動物保護區的族群顯示相同的翅鞘斑紋，並且觀察到與螞蟻共域的現象。我們的調查結果不僅記錄台中大甲溪口步行蟲的組成，也暗示著臺灣對於沿海地區昆蟲相的調查不足。

關鍵詞: 海濱步行蟲、*Desarmatocillenus*、大甲溪口

[研究文章 Research Article]

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Bat Flies (Diptera: Hippoboscoidea) Associated with Fruit Bats (Pteropodidae) on Cebu Island, Philippines

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Abstract: The bat fly fauna of Cebu Island is poorly studied as evidenced by relatively few published records. This paper presents records of bat flies (Diptera: Hippoboscoidea) associated with fruit bats on Cebu Island, Philippines with additional island records. These records are as follows: *Cyclopodia horsfieldi* (ex. *Pteropus hypomelanus* & *P. pumilus*), *Leptocyclopodia ferrarii mabuhai* (ex. *Cynopterus luzoniensis*), and *Leptocyclopodia pilosipectus* (ex. *Harpyionycteris whiteheadi*). This account serves as the first checklist of bat flies occurring in Cebu Island.

Keywords: Chiroptera, central Visayas, ectoparasites, new bat fly records

Introduction

Cebu Island is one the major islands in the Central Philippines and lies within the Visayas Block, a constituent of the seismically active Philippine Mobile Belt (Burton 1986; Mendoza et al. 2022). Cebu Island was dated to have originated during the early Cretaceous period (Deng et al. 2015). This long and narrow island has a land area of approximately 5, 088 square kilometers (Supsup et al. 2016) and is characterized by hilly terrain. Cebu is known for its karst landscape (Restificar et al. 2006; Lumongsod et al. 2022). This karst topography serves as the substrate of the remaining karst forests on the island and is home to a variety of vascular plants (Cadiz & Buot, Jr. 2010; Replan & Malaki 2017; Lillo et al. 2019). In terms of biogeographic affinity, Cebu Island is part of the Negros-Panay faunal region based on the Pleistocene Aggregate Island Complexes model (PAIC) (Vallejo, Jr. 2011). This faunal region is comprised of Ticao, Masbate, Negros, Panay, Cebu, and smaller adjacent islands (Heaney 1986; Vallejo, Jr. 2011).

Cebu Island is home to 29 species of bats belonging to 21 genera (Heaney et al. 2010). Of these, 13 species are fruit bats (Pteropodidae) and 6 are Philippine endemics (Paguntalan & Jakosalem 2007; Heaney et al. 2010). Associated ectoparasites of bats such as bat flies are understudied as evidenced by a few published records for the group on Cebu Island. In this paper, new geographic records of bat flies (Diptera: Hippoboscoidea) associated with fruit bats on Cebu Island are presented. Our account serves as the first checklist of bat flies on Cebu Island.

Material and Methods

Ethanol-preserved (95%) bat flies were examined under a LeicaS9D stereomicroscope. The keys of Theodor (1963) and Cuy (1980) were used to identify bat flies. Focus stacking of representative specimens was done using Helicon Focus (Helicon Soft Ltd., Ukraine). The nomenclature of hosts and bat flies follows Giannini et al. (2019) and Graciolli and Dick (2018), respectively. Examined specimens will be deposited in the National Museum of Natural Science (Taichung, Taiwan).

Results and Discussion

Order Diptera Linnaeus [true flies]
Parvorder Calyptratae Robineau-Desvoidy [calyptrate flies]
Superfamily Hippoboscoidea Samouelle [hippobscoid flies]
Family Streblidae Kolenati

***Megastrebla parvior* (Maa, 1962) (Fig. 1)**

Material examined: ex. *Rousettus amplexicaudatus* Geoffroy: 3♀♀, Alcoy, Cebu, 2015, local collector.

Family Nycteribiidae Samouelle

***Cyclopodia horsfieldi* de Meijere 1899 (Fig. 2)**

Material examined: ex. *Pteropus hypomelanus* Temminck: 1♂, 1♀, Alcoy, Cebu, 2015, local collector; On *Pteropus pumilus*: 2♂♂, Alcoy, Cebu, 2015, local collector.

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***Leptocyclopodia ferrarii mabuhai* Maa, 1975**

Material examined: ex. *Cynopterus luzoniensis* (Peters): 1♀, Alcoy, Cebu, 2015, local collector.

***Leptocyclopodia pilosipectus* Maa, 1966**

Material examined: ex. *Harpyionycteris whiteheadi* Thomas: 1♂, Alcoy, Cebu, 2015, local collector.

***Leptocyclopodia simulans* Theodor, 1959**

Material examined: ex. *Ptenochirus jagori* (Peters): 1♂, Alcoy, Cebu, 2015, local collector.

There were only four species of streblid and nycteribiid bat flies previously reported on Cebu Island. Maa (1971) reported *M. parvior* based on specimens collected on *Rousettus amplexicaudatus* from Minglanilla, central Cebu. Cuy (1980) provided the records of *Eucampsipoda inermis* and *L. simulans* of Cebu Island. Subsequently, Hastriter (2007) reported *Maabella stomalata* in Cebu from Minglanilla collected in 1962 from *R. amplexicaudatus*. The newly recorded streblid and nycteribiids with host records along with previously recorded species are summarized in table 1.

Despite these additional records, the bat fly fauna on Cebu Island is insufficiently studied. With deforestation and disruption of the environment, future surveys and exploration of the karst landscape is urgently needed. Furthermore, it is also worthy to examine the impact of these parasites on their hosts and the associated microbes that inhabit them.

Table 1. Checklist of bat flies recorded on Cebu Island.

Bat fly species	Host records in Cebu	References
Cyclopodia horsfieldi de Meijere	*Pteropus hypomelanus; P. pumilus*	***this study**
Eucampsipoda inermis Theodor	Unspecified on the list	Cuy 1980
Leptocyclopodia ferrarii mabuhai Maa	*Cynopterus luzoniensis*	***this study**
Leptocyclopodia pilosipectus Maa	*Harpyionycteris whiteheadi*	***this study**
Leptocyclopodia simulans Theodor	Unspecified on the list	Cuy 1980
Maabella stomalata Hastriter & Bush	*Rousettus amplexicaudatus*	Hastriter 2007
Megastrebla parvior (Maa)	*Rousettus amplexicaudatus*	Maa 1971; ***this study**

Figure 1. Habitus of female *Megastrebla parvior* (Maa, 1962) (dorsum).

Figure 2. Habitus of male(A) and female (B) *Cyclopodia horsfieldi* de Meijere, 1899 (ventrum).

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菲律賓宿霧島上狐蝠的蝠蠅（雙翅目：蠅總科）

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摘要：宿霧島上蝠蠅相的研究資料非常少，僅有寥寥數筆紀錄。本研究描述了宿霧及其他島上的蝠蠅和與之相關的狐蝠，如：*Cyclopodia horsfieldi* (ex. *Pteropus hypomelanus* & *P. pumilus*), *Leptocyclopodia ferrarii mabuhai* (ex. *Cynopterus luzoniensis*) 和 *Leptocyclopodia pilosipectus* (ex. *Harpyionycteris whiteheadi*)。本研究提供宿霧島的第一份蝠蠅名錄。

關鍵詞：翼手目、外寄生蟲、喀斯特、蛛蠅科、蝠蠅科

[研究文章 Research Article]

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The Real Status of *Chlorogomphus splendidus* (Selys, 1878) in Taiwan (Odonata: Chlorogomphidae)

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Abstract: The single record of *Chlorogomphus splendidus* (Selys, 1878) in Taiwan was based on a single female specimen collected from Lanyu Island in eastern Taiwan. The status of this species in Taiwan has remained uncertain for nearly a century, as no new material is available for study. Upon the capture of a female *C. risi* Chen, 1950 in 2010 from the island, we decided to re-examine the voucher specimen of *C. splendidus* and compared it with the female *C. risi*. The result reveals that Lanyu *C. splendidus* is a pale-winged female *C. risi*. Hence, *Chlorogomphus splendidus* has to be excluded from the list of Taiwanese Odonata.

Keywords: Dragonfly, Anisoptera, Lanyu Island, misidentification

Introduction

Chlorogomphus Selys is a large genus that includes 47 species (Schorr et al., 2022). Among them, 3 species have beenrecorded from Taiwan, viz., *C. brevistigma* Oguma, 1926, *C. risi* Chen, 1950, and *C. splendidus* (Selys, 1878). Both *C. brevistigma* and *C. risi* are endemic to Taiwan and generally widespread on the island and have been well-documented (Matsuki, 1983; Matsuki & Lien, 1983). *Chlorogomphus splendidus* was described from Luzon, Philippines, based only on a single female specimen (Selys, 1878). The species was subsequently reported also from different countries, including Taiwan, northern Vietnam and Malaysia (Borneo) (Martin 1904; Ris 1912; Laidlaw 1914; Fraser 1929;). In Taiwan, Ris (1912) reported three males of *C. splendidus* from Jiaxian (= Kosempo) and Fengshan (= Hoozan or Hozan), both located in Kaohsiung City. The statuses of these males were doubted by Fraser (1929) and subsequently clarified by Chen (1950) to represent a new species, *Chlorogomphus risi*. Chujo (1930) reported a female of *C. splendidus* from Lanyu Island of Taitung County in eastern Taiwan. Chen (1950) examined this female and also recognized it as *C. splendidus*, albeit with some doubt. Chen's concept of the Lanyu female as *C. splendidus* was generally followed by later authors who listed this species in the dragonfly fauna of Taiwan (Matsuki & Lien, 1983; Lieftinck et al., 1984). So far, the male of *C. splendidus* remains unknown, making the identity of this species uncertain and confusing.

In 2010, a female *C. risi* (Fig. 2E) was collected from Lanyu Island, and this led to a question about whether the female *C. splendidus* reported by Chujo from the island is, in fact, a female *C. risi.* To answer this question, we re-examined the voucher specimen of Lanyu *C. splendidus* deposited in Taiwan Agricultural Research Institute (TARI) and compared it with the female specimens of *C. risi* from the main island of Taiwan.

Materials and methods

The habitus photos were taken by Nikon D60 SLR digital camera with a Micro-Nikkor 60 mm f/2.8 lens. The photos were then edited by Adobe Photoshop CS5 if needed. Plates were prepared by Adobe Illustrator CS5 and Adobe Photoshop CS5. The voucher specimen of *C. splendidus* of Chujo (1930) was deposited in TARI (Taiwan Agricultural Research Institute, Taichung, Taiwan) and the other specimens of *C. risi* were collected by the first author and deposited in TFRI (Taiwan Forestry Research Institute, Taipei, Taiwan).

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Results and discussion

Materials examined.

Chlorogomphus splendidus – 1 female, 10.III-14.IV.1920 (J. SONAN & T. OKUNI) (TARI).

Chlorogomphus risi - Taipei City: 1 female (teneral), Neishuangxi, 1997/VI/29; 1 female, Shilin, Qixingshan summit, 2014/6/27; 1 female (teneral), Mucha, Taipei Zoo, 2008/4/27. New Taipei City:1 female, Shiding, 1995/2/13; 1 female, Xindian, Guishan, 1995/6/2; 1 female, Pinglin, 1996/6/29; 1 female, Gongliao, Hemei, 1998/6/27; 1 female, Xizhi, Kezilin, 2002/5/5. Yilan County: 1 female, Yuanshan, Fushan Botanical Garden, 1995/6/27; 1 female, ditto., 1997/6/22; 1 female, ditto., 1997/7/7. All specimens were collected by WCY (TFRI).

According to Chen (1950), the female Lanyu *C. splendidus* differs from the female *C. risi* as follows: wings brown on bases, nodal areas and apex in the Lanyu *C. splendidus* (Fig. 1A) but entirely golden yellow in *C. risi* (Fig. 1B); ante-alar ridges are black in the Lanyu *C. splendidus* (Fig. 2C) and yellow in *C. risi* (Fig. 2D). However, the wing pattern is variable in female *C. risi*, of which at least three types can be clearly defined, viz. pale- (Fig. 1C & D), semi-dark-(Fig. 2A) and dark-winged (Fig. 2B). The female wing pattern of Lanyu *C. splendidus* doesn't differ from the first type. Direct inspection on the Lanyu female also revealed the black ante-alar ridges, in fact, retained some yellowish traces, suggesting the black was probably caused by postmortem discoloration; hence, the Chen's arguments to separate the female Lanyu *C. splendidus* from female *C. risi*is not feasible.

Furthermore, the color pattern on the lateral side of the 2nd abdominal segment is usually species-specific in the females of *Chlorogomphus* and this feature is not different between the female Lanyu *C. splendidus* and *C. risi*. In conclusion, we confirm that the female Lanyu *C. splendidus* is a misidentification of a pale-winged female *C. risi*.

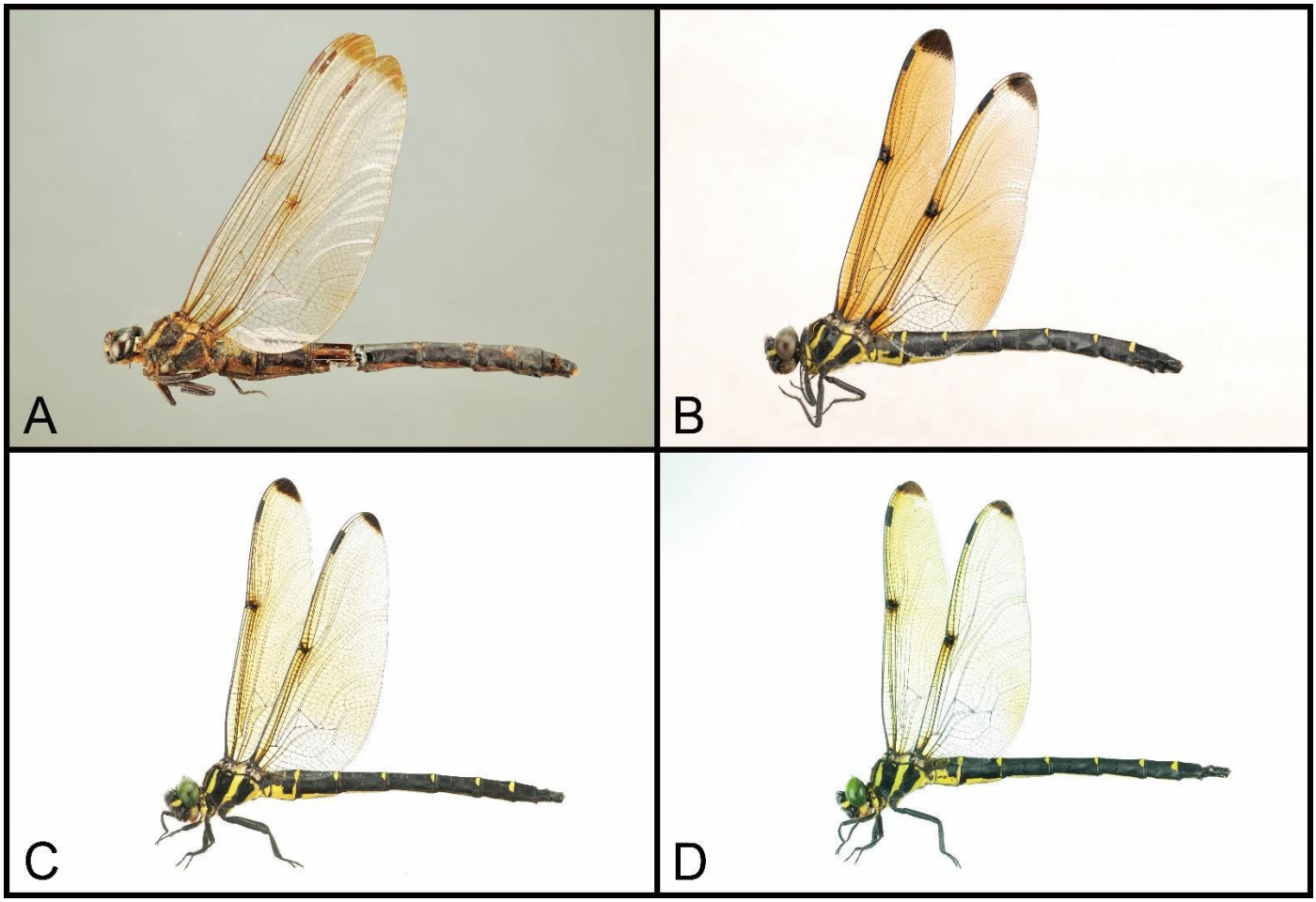

Figure 1. Female specimens of *Chlorogomphus risi*. A, the voucher specimen of *C. splendidus* in Chujo (1930); B, teneral female; C, D, pale-winged females.

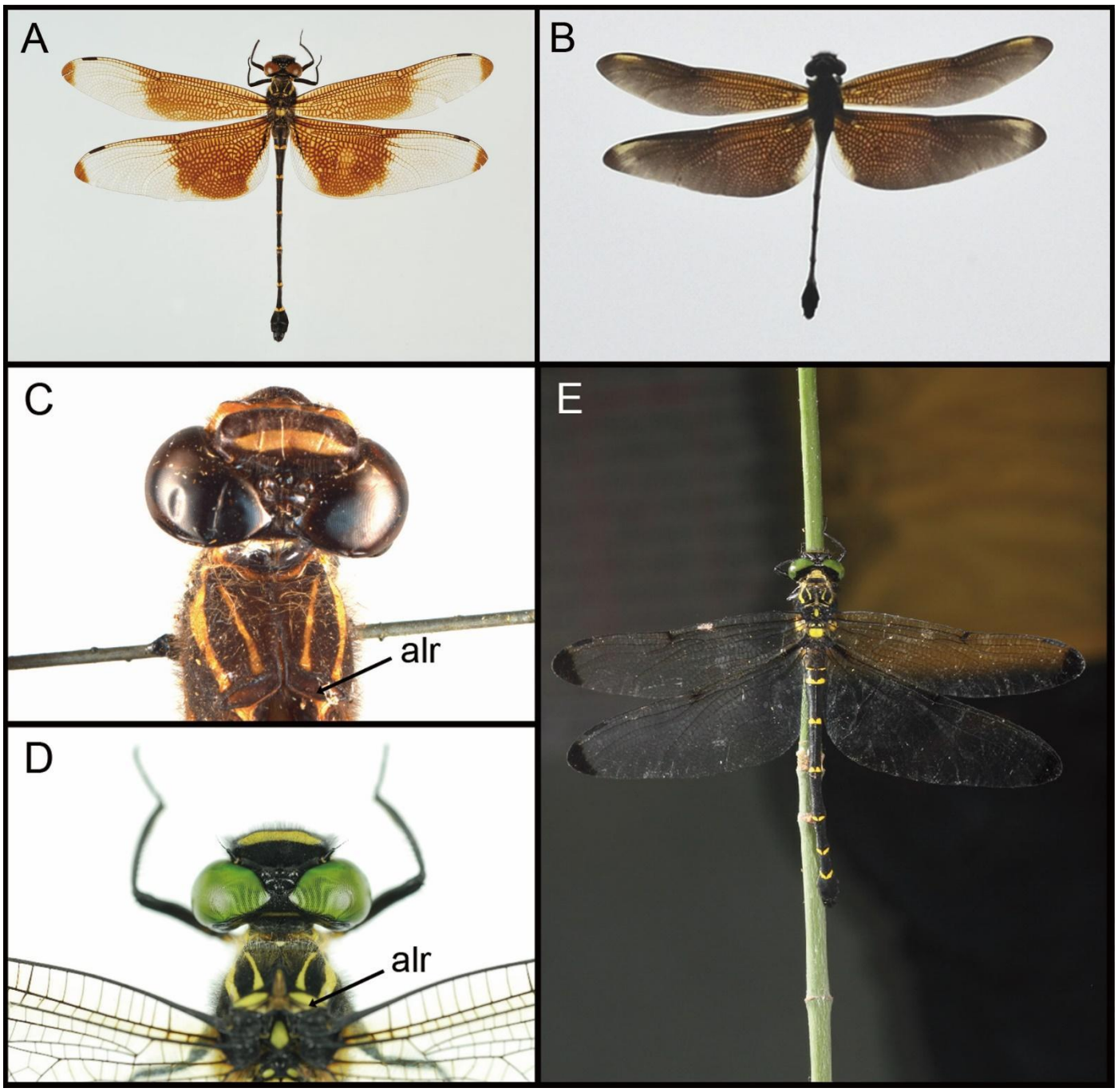

Figure 2. Female specimens of *Chlorogomphus risi*. A, semi-dark-winged female; B, dark-winged female; C, head and thorax of voucher specimen of *C. splendidus* in Chujo (1930); D, head and thorax of *C. risi*; E, the female *C. risi* photographed by Chia-Hung Lin in 2010 from Lanyu Island, Taitung. Abbreviation: alr: ante-alar ridge.

Acknowledgments

We thank Chia-Hung Lin for providing the photo of the female *C. risi* from Lanyu Island. We also thank Chi-Feng Lee (TARI, Taichung), who made the voucher specimen of Lanyu *C. splendidus* available for close examination.

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臺灣產闊翼斑蜓的真實身分（蜻蜓目：斑蜓科）

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摘要: 臺灣產闊翼斑蜓 (*Chlorogomphus splendidus* (Selys, 1878)) 的紀錄原本是根據一隻採自蘭嶼的雌性標本，由於後續沒有新採集的標本，本種是否分布於臺灣的問題已將近百年仍未確定。2010 年因為有人在蘭嶼採集到臺灣本島特有的褐翼斑蜓 (*C. risi* Chen, 1950)，我們決定重新檢視蘭嶼產闊翼斑蜓的存證標本，並與褐翼勾蜓互相比對，結果顯示該蘭嶼闊翼斑蜓標本實際為褐翼斑蜓淡翅型雌蟲的錯誤鑑定，據此，我們將闊翼斑蜓從臺灣的蜻蜓目名錄中排除。

關鍵詞: 蜻蜓、不均翅亞目、蘭嶼、錯誤鑑定

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Indothemis carnatica (Fabricius, 1798) (Odonata: Libellulidae): A Newly Recorded Dragonfly from Kinmen Islands and Matsu Islands, Taiwan

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Abstract: Herein, we report a new record of the dragonfly *Indothemis carnatica* (Fabricius, 1798) from Kinmen Islands and Matsu Islands based on either collected specimens or observation records, representing the first record of the species in Taiwan and Fujian. Photos of habitus, live specimens and habitats are also provided. Finally, we briefly discussed the current status of the species on both island groups.

Keywords: Fujian, fauna, Kinmen County, Lienchiang County, Oriental, Anisoptera

Introduction

Indothemis carnatica (Fabricius, 1798) was originally restricted in a few localities in India, Sri Lanka, and Thailand and hence was treated as a "Near Threatened" species in the IUCN Red List (Dow, 2009). However, this species has likely spread into various countries in recent years. Numerous new country records were reported: Cambodia (Roland et al., 2011), Malaysia (Choong & Cheah, 2013), Vietnam (von Ellenrieder et al., 2015), China (Hong Kong, Yunnan, Guangxi, Guangdong) (Odonata Research, 2016; AFCD, 2018; Zhang, 2019), Singapore (Soh et al., 2019), and Bangladesh (Kalkman et al., 2020). An increase in the number of individuals was also observed in Hong Kong (Wu, 2020). As a result, the IUCN Red List treated *I. carnatica* as a “Least Concern” species after re-evaluating the population's current status (Dow, 2019).

The fauna of Kinmen Islands and Matsu Islands is more similar to the Fujian Province of mainland China compared to Taiwan Island due to geographical proximity. Both island groups are very close to the eastern coast of Fujian Province, People's Republic of China (ca. 10 to 20 km). Insect surveys of both island groups are relatively poorly done (Shih et al. 2004). During a preliminary survey, Lien (1980) reported 16 species of Odonata from Kinmen. Tung & Yang (2008) conducted a systematic survey of the insect fauna and further recorded 15 additional species for the islands. Two new records of damselflies: *Pseudagrion rubriceps* Selys, 1876 and *Prodasineura autumnalis* (Fraser, 1922) were reported in the local field guidebook (Chang, 2011). Both species are only found in the Kinmen within the country, highlighting the unique fauna of the region. Abundant new records from the Kinmen indicated that the fauna there is still largely unknown, especially for the aquatic insects (etc. Liu et al. 2021, 2022). The only source of the Odonata survey in Matsu is Wu (2002) who reported that at least 14 species were found on the islands, but in reality, Wu (2002) only illustrated 12 species.

In the present study, we report *I. carnatica* in Taiwan and Fujian Province for the first time based on the specimens collected from Kinmen and the observation records from both Kinmen and Matsu.

Materials and methods

The voucher specimens are preserved in the following depositories: CHMc – Chen-Han Ma’s private collection, Taipei, Taiwan; FSHc – Fang-Shuo Hu’s private collection, Yilan, Taiwan; TFRI – Taiwan Forestry Research Institute, Taipei, Taiwan (W.-C. Yeh). The identity of the specimens was based on comparing the specimens and the descriptions and illustrations of *I. carnatica* in von Ellenrieder et al. (2015), Zhang (2019) and Joshi & Sawant (2020). Specimens were examined by Olympus SZ61 Stereo Microscope. Photos of habitus and morphological characters were photographed by Canon EOS R5 with Canon RF100mm f/2.8L MACRO IS USM lens. Plates were prepared by Adobe Photoshop CS5.

Results

藍印蜻蜓

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***Indothemis carnatica* (Fabricius, 1798)**
(Figs 1, 2A)

Material examined: TAIWAN: Kinmen County: 1 female, Maoshan Pagoda (茅山塔), Jincheng Township (金城鎮), 24.4081, 118.2871, 24-IX-2022, leg. K.-T. Lin (FSHc); 1 teneral male and 1 teneral female, same information as the previous one except for the date, 25-IX-2022 (TFRI); 2 females, same locality as previous ones, 02-X-2022, leg. C.-H. Ma (CHMc, FSHc); 1 female, same information as the previous one except for the date, 04-X-2022 (CHMc).
Observation records: TAIWAN: Lienchiang County (=Matsu Islands): 1 male, Zhongxing Reservoir (中興水庫), Beigan Township (北竿鄉), 26.2206, 119.9928, 14-VI-2020, obs. S.-L. Chen; 9 males and 1 female, Dongju Island (東莒島), Fuzheng Reservoir (福正水庫), Juguang Township (莒光鄉), 25.9633, 119.9825, 16-VI-2020, obs. S.-L. Chen; 1 male, 01-VII-2020; 1 female, 02-VII-2020; 2 males, 03-VII-2020, obs. H.-I. Chiou; 5 males, same information as the previous one except for the date, 05-VII-2020; 2 males, Jinsha Reservoir (津沙水庫), Nangan Township (南竿鄉), 26.1447, 119.9157, 17-VI-2020, obs. S.-L. Chen; 1 male, same information as the previous one except for the date, 04-VII-2020; 2 males, Jinsha No. 1 Dam (津沙一號壩), Nangan Township (南竿鄉), 26.1485, 119.9150, 17-VI-2020, obs. S.-L. Chen; 1 male, Zhiqing Power Plant (志清發電廠), Nangan Township (南竿鄉), 26.1497, 119.9288, 17-VI-2020, obs. S.-L. Chen. **Kinmen County:** 1 male, Caicuo Historical Trail (蔡厝古道), Jinsha Township (金沙鎮), 24.4708, 118.4192, obs. S.-C. Huang; 1 female, Maoshan Pagoda (茅山塔), Jincheng Township (金城鎮), 24.4081, 118.2871, 24-IX-2022, obs. K.-T. Lin; 1 male and 1 female, same locality as previous one, 11-IX-2022, obs. J.-G. Ho; 1 female, same information as the previous one except for date, 12-IX-2022; 1 female, same locality as previous one, 04-X-2022, obs. C.-H. Ma.

Diagnosis.

The fore wings are entirely hyaline; the base of the hind wings with small brown spots. Both fore wings and hind wings are without brown spots on the tips of wings (with small spots on the tips of wings in *I. limbata* (Selys, 1891)). Synthorax humeral stripe thick, trident at the end; antehumeral stripe present, sometimes connect with humeral stripe. Interpleural stripe and metapleural stripe distinct, interpleural stripe truncate on the top; metapleural stripe complete, both stripes connected by a thin black stripe in the position of metastigma. Mature male compound eyes brownish and dark blue, thorax and abdomen black, covered by blue pruinosity, teneral male similar to female in general habitus. Female compound eyes brownish and yellowish green, thorax yellow, abdomen black with yellowish markings.

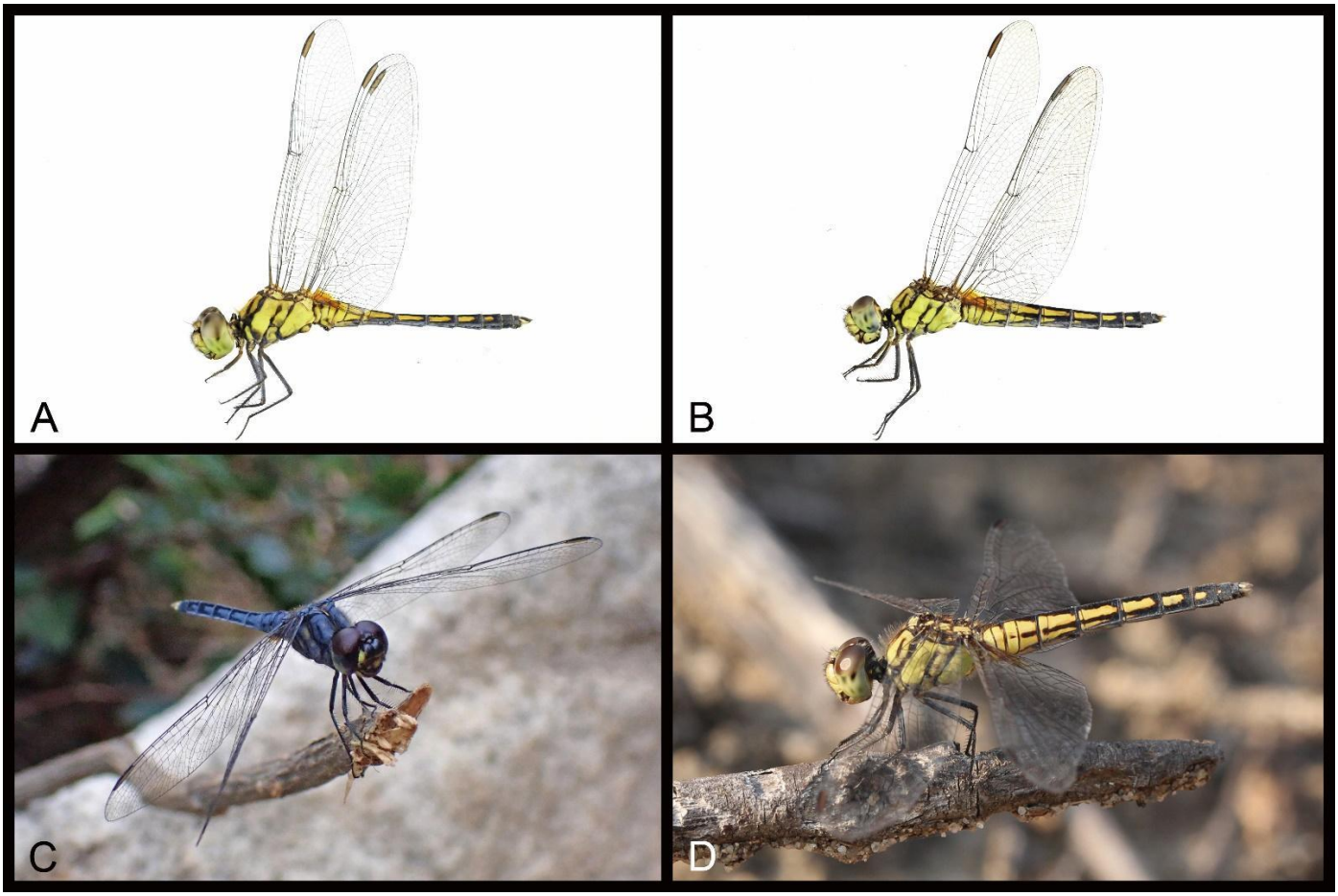

Figure 1. Specimens and live photos of *Indothemis carnatica* (Fabricius, 1798): A – teneral male (photo by I.-L. Lee); B – mature female (photo by I.-L. Lee); C – mature male (photo by S.-C. Huang); D – mature female (photo by C.-H. Ma).

Distribution.

Indothemis carnatica is widely distributed in the Oriental Region, including Bangladesh, Cambodia, China (Yunnan, Guangxi, Guangdong, Hong Kong), India, Malaysia, Singapore, Sri Lanka, Thailand and Vietnam (AFCD, 2018; Zhang, 2019; Soh et al., 2019; Kalkman et al., 2020). In addition, the species is newly recorded in Taiwan (Kinmen County and Lienchiang County). There is also a record of the species from Sanya, Hainan, China (18.221525, 109.432068) on iNaturalist (https://www.inaturalist.org/observations/12236973), we report it as a new province record herein.

Bionomics.

All individuals observed in Matsu inhabited the open ponds with some weeds on the waterside (Figs 2C–F). A mating pair of *I. carnatica* were observed by the second author in Fuzheng Reservoir (福正水庫), and oviposition was also observed at the same time. The collecting locality Maoshan Pagoda (茅山塔) in Kinmen is near the seashore, with strong winsd but without fresh water nearby, the dragonflies observed were perching on the twigs or ground (Fig 2A–B).

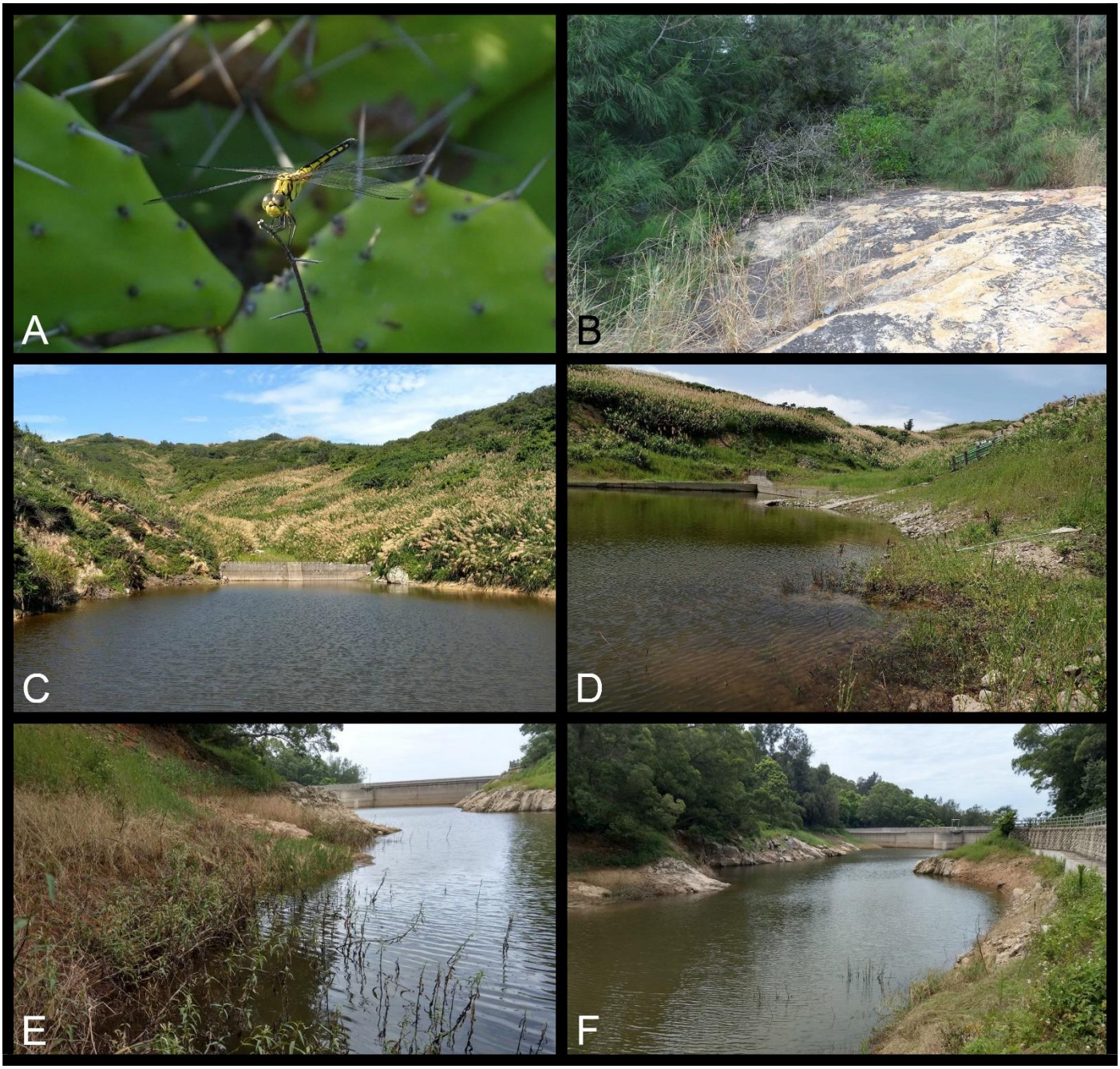

Figure 2. Habitats of *Indothemis carnatica* (Fabricius, 1798) from Kinmen and Matsu: A – mature female perching on the twig; B - Maoshan Pagoda (茅山塔), Kinmen; C, D - Fuzheng Reservoir (福正水庫), Matsu; E, F - Jinsha Reservoir (津沙水庫), Matsu.

Discussion

It is still unclear whether the *I. carnatica* recorded from Kinmen and Matsu are residents or vagrants, as in some *Sympetrum* spp. on Taiwan Island (Ma et al. 2022). In Matsu, the open ponds where the egg-laying female was observed, with a few weeds on the waterside fit the reported habitats of the species (Choong & Cheah, 2013; Soh et al., 2019). Hence, the individuals found in Matsu probably represent a resident population. There is no fresh water source nearby the locality in Kinmen, where the wind is also strong; The habitat is actually similar to that of the immigrated *S. fonscolombii* (Selys, 1840) in Taiwan (Ma et al., 2022). Additionally, the immigration of *I. limbata* has already been observed in Yunnan, China (Zhang, 2017), a fact that implies *I. carnatica* may also have such behavior. A systematic survey of the Odonata fauna in Kinmen and Matsu in the future, including larvae collecting in proper ponds, may help to clarify the real status of *I. carnatica* in these islands.

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藍印蜻蜓（蜻蜓目：蜻蜓科）：臺灣金馬地區新紀錄種蜻蜓

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摘要: 金門與馬祖的昆蟲相較為缺乏調查，本文根據標本與觀察紀錄報導來自這兩個島群的臺灣新紀錄種蜻蜓：藍印蜻蜓 (*Indothemis carnatica* (Fabricius, 1798))。本文亦提供標本之整體照、活體照與棲地照片，並簡短討論藍印蜻蜓在兩個島群的定位為固留種或迷蜓。

關鍵詞: 福建、動物相、金門縣、連江縣、東方區、差翅下目

[研究文章 Research Article]

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An Amendment on the Record of *Rhyothemis fuliginosa* Selys, 1883 in Taiwan — a Newly Discovered Gynomorphic Wing Pattern in Female *R. regia regia* (Brauer, 1867) (Odonata: Libellulidae)

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Abstract: The identity of Taiwanese *Rhyothemis fuliginosa* Selys, 1883 is clarified to be the gynomorphic female of *R. regia regia* (Brauer, 1867). Female Taiwanese *R. r. regia* differ from female *R. fuliginosa* mainly in having paler face with weak metallic lustre, anteriorly more strongly incurved postclpyeus and stouter cerci. The reported wing patterns of various subspecies of *R. regia* are compiled from the literature for comparison. A transitional variation of the female wing pattern of Taiwanese *R. r. regia* varying from andromorphic to gynomorphic is illustrated. The case of range expansion caused by climatic warming in *R. r. regia* and other libelullid dragonflies in Taiwan is elucidated.

Keywords: Polymorphic, subspecies, climatic warming, range expansion

Introduction

After Lieftinck et al. (1984), two additional *Rhyothemis* species have been recorded from Taiwan, that are *R. fuliginosa* Selys, 1883 and *R. r. regia* (Brauer, 1867). *Rhyothemis fuliginosa* is a temperate species of libellulid dragonfly, formerly only recorded from China, Japan and the Korean Peninsula in East Asia (Tsuda, 2000), but its range could reach as south as to Fujian (Needham, 1930). It was reported for the first time as a seasonal vagrant from northern Taiwan in 2007 (Yeh et al., 2007), but so far only its females were collected from the island. *Rhyothemis regia* is a polymorphic species which inhabits the Indo-Pacific region, with eight subspecies, viz. *R. r. armstrongi* Fraser, 1956, *R. r. chalcoptilon* (Brauer, 1867), *R. r. exul* Ris, 1913, *R. r. juliana* Lieftinck, 1942, *R. r. pretiosa* Selys, 1878, *R. r. regia*, *R. r. thisbe* Lieftinck, 1953 and *R. r. uveae* Marinov, 2021, spreading over a transverse belt extending from Sabang and Simaloer in western Sumatra in the west, through the central and southern islands of the Philippines, northern Celebes, the Moluccas to northern New Guinea. Strangely, the boundary of the range is far away eastwards to Samoa and Wallis Islands in the South Pacific Ocean and northwards to Saipan and Pagan Islands in the western Pacific Ocean, without any sole record reported from in-between (Lieftinck, 1959, fig. 2). Different subspecies of *R. regia* are well isolated from each other in small insular islands or coastal areas of larger islands, but some could distribute over a wider area as in *R. r. regia* (Sumatra to Philippines), or occur in remotely disjunct localities as in *R. r. chalcoptilon* (Samoa and Saipan). These subspecies were structurally undifferentiated and could only be separated by wing pattern (Lieftinck, 1959).

Another confusing matter regarding the record of *R. fuliginosa* in Taiwan, except that only female specimens were collected, is that the females were frequently observed to copulate with the males of *R. r. regia* (Han-Ian Chiou, personal communication). The copulated females even performed normal oviposition behaviors after mating. The above observations have puzzled local researchers about the real identity of Taiwanese *R. fuliginosa* for years and led the author to explore the issue in detail. The result is presented here with a discussion on the status of *R. r. regia* in Taiwan and its range expansion caused by climatic warming.

Materials and methods

The females of Taiwanese *R. fuliginosa* were directly compared with the two females of Japanese *R. fuliginosa* and the females of Taiwanese *R. r. regia*. All specimens examined were listed below. All specimens are deposited in Taiwan Forestry Research Institute, Taipei, Taiwan (TFRI).

Japanese *R. fuliginosa* — 2♀♀, Shizuoka, Japan, 4/VIII/2012, leg. S. L. Chen & I-Lung Lee.

Taiwanese *R. fuliginosa* — 1♀, Xinyi district, Keelung City (基隆市汐止區), 9/X/2006, leg. J. H. Wu; 1♀, Xinyi district, Jilong City, 10/X/2006, leg. H. I. Chiou; 1♀, Xinyi district, Keelung City, 18/VII/2008, leg. H. I. Chiou.

Taiwanese *R. r. regia* — 1♂, Datong, Yilan County (宜蘭縣大同), 7/VII/2011, leg. W. C. Yeh; 2♂♂, Dawu, Taitung County (台東縣大武), 30/V/2007, leg. W. C. Yeh; 1♂, Xindian, New Taipei City (新北市新店), 10/IIV/2000, leg. W. C Yeh; 1♀, Neipu, Pingtung County (屏東縣內埔), 15/IV/1996, leg. J. S. Chen; 1♀, Neipu, Pingtung County, 12/X/2004, leg. W. C. Yeh; 1♀, Xinyi district, Keelung City, 30/IX/2007, leg. H. I. Chiou.

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The wing patterns of various subspecies of *R. regia* were compiled from Lieftinck (1926, 1942, 1948 & 1959), Marinov (2021) and Ris (1912, 1913) and shown in Figs 1–29. The Minahassa female of *R. r. regia* (Figs 1–14) in Ris (1912) (pl. 6, right upper) has discoidal fenestrae on hind wings and does not belong to the nominate subspecies. It shares a similar wing pattern to the Ternate male of *R. r. pretiosa* (Figs 1–13) in Ris (1913) (pl. 6, left upper; originally as *R. r. regia* but see Lieftinck 1953a) and is recognized here as that subspecies. The Samoan male and female originally identified by Lieftinck (1959) as *R. r. chalcoptilon* is recognized here as *R. r. armstrong*i (see Marinov, 2021).

Results

Direct inspection of the two female Japanese *R. fuliginosa* revealed some features, other than wing pattern, that are different from those of the female Taiwanese *R. fuliginosa*. In the Taiwanese females, the face is yellowish-brown at middle, including clypeus and lower margin of antefrons, with weaker metallic lustre especially on the postclypeus; the postclypeus is more strongly and deeply incurved at anterior margin with lateral lobes relatively larger (Fig. 30); the cerci are stouter (Fig. 31) and the subgenital plate is more deeply and widely notched apically (Fig. 32). The Japanese females have, in comparison with the Taiwanese females, almost entirely black face with strong metallic lustre, a differently shaped postclypeus (Fig. 33), more slender cerci (Fig. 34) and a more shallowly notched subgenital plate (Fig. 35). Other differential features between the females of Japanese and Taiwanese *R. fuliginosa* include: the hairs covering the apical abdominal segments are longer and denser in the Japanese females but shorter and sparser in the Taiwanese females; the Taiwanese females have denser venation than in the Japanese females, with costal cross-vein numbers 11–13:10–12:11–13:11–13 in forewings and 11–13:6–8:7–8:11–15 in hindwings (8–9:9:9:8–9 in forewing and 8–9:6:6:8–9 in hindwings in the Japanese females); 9th sternite is generally black including a pair of styli in the Japanese females (Fig. 35) but yellowish-brown at base and the styli in the Taiwanese females (Fig. 32).

The female Taiwanese *R. fuliginosa* were further compared with the female Taiwanese *R. r. regia* and the result showed no distinct differences between them, except in wing pattern. The final conclusion is that the female Taiwanese *R. fuliginosa* in fact represents a new gynomorphic wing pattern of female *R. r. regia* that has never been reported before, although Lieftinck (1948) did show one similar example from Sabang, Sumatra (Figs 1–8). This new wing pattern is similar to that of the gynomorphic females of Japanese *R. fuliginosa* as shown in Sugimura et al. (2001, p. 282). However, the former has a dark area of hind wing a little less extensive in comparison to the latter, with the outer margin of the dark area being distinctly basal to pterostigma (reaching or exceeding pterostigma in the latter). Intra-specifically, this wing pattern is most similar to that of the Sabang female mentioned above. As in the Sabang female, the gynomorphic females of Taiwanese *R. r. regia* usually possess two faint fenestrae (more distinct in the Sabang female) on hind wing just outside of nodus, one close to anterior margin and the other to posterior margin. These fenestrae are also absent in female Japanese *R. fuliginosa*.

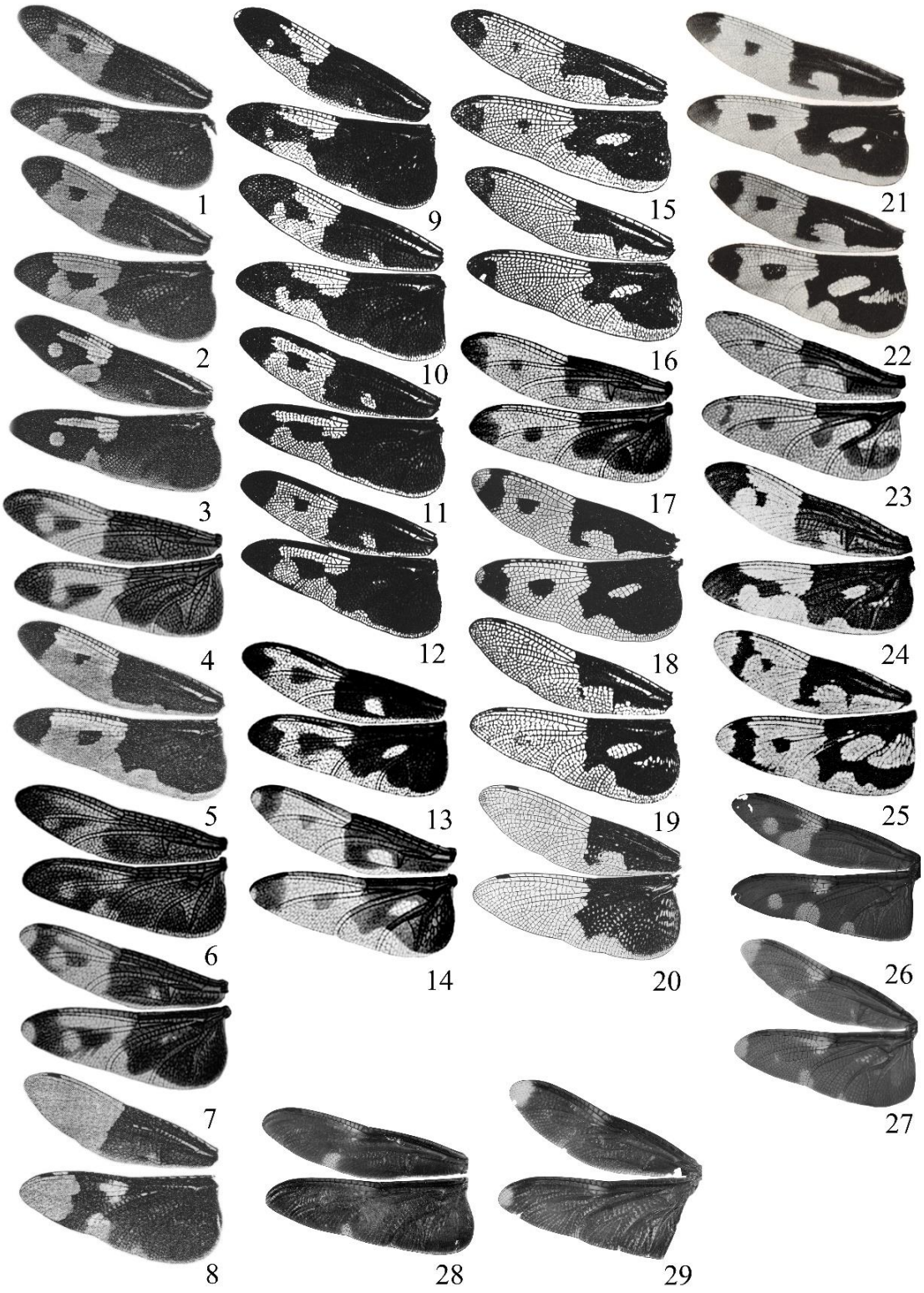
Discussion

Dichromatic variation in female wing pattern is common in the genus *Rhyothemis* (Lieftinck, 1959) and in *R. regia* has been reported for the subspecies of *R. r. exul* (Lieftinck 1942), *R. r. thisb*e (Michalski, 2012) and *R. r. chalcoptilon* (Lieftinck, 1959). The wing patterns of *R. r. regi*a recorded from Taiwan are also variable and the variation is more pronounced in the female than in the male (Figs 36–42). A series of transitional variation in female wing pattern of Taiwanese *R. regia regia* could be found, varying from fully andromorphic type (Fig. 39) to extremely gynomorphic type (Figs 42–43), with the apical transparent area becoming larger toward the latter type.

The cases of range expansion toward the north caused by climatic warming in Taiwanese dragonflies

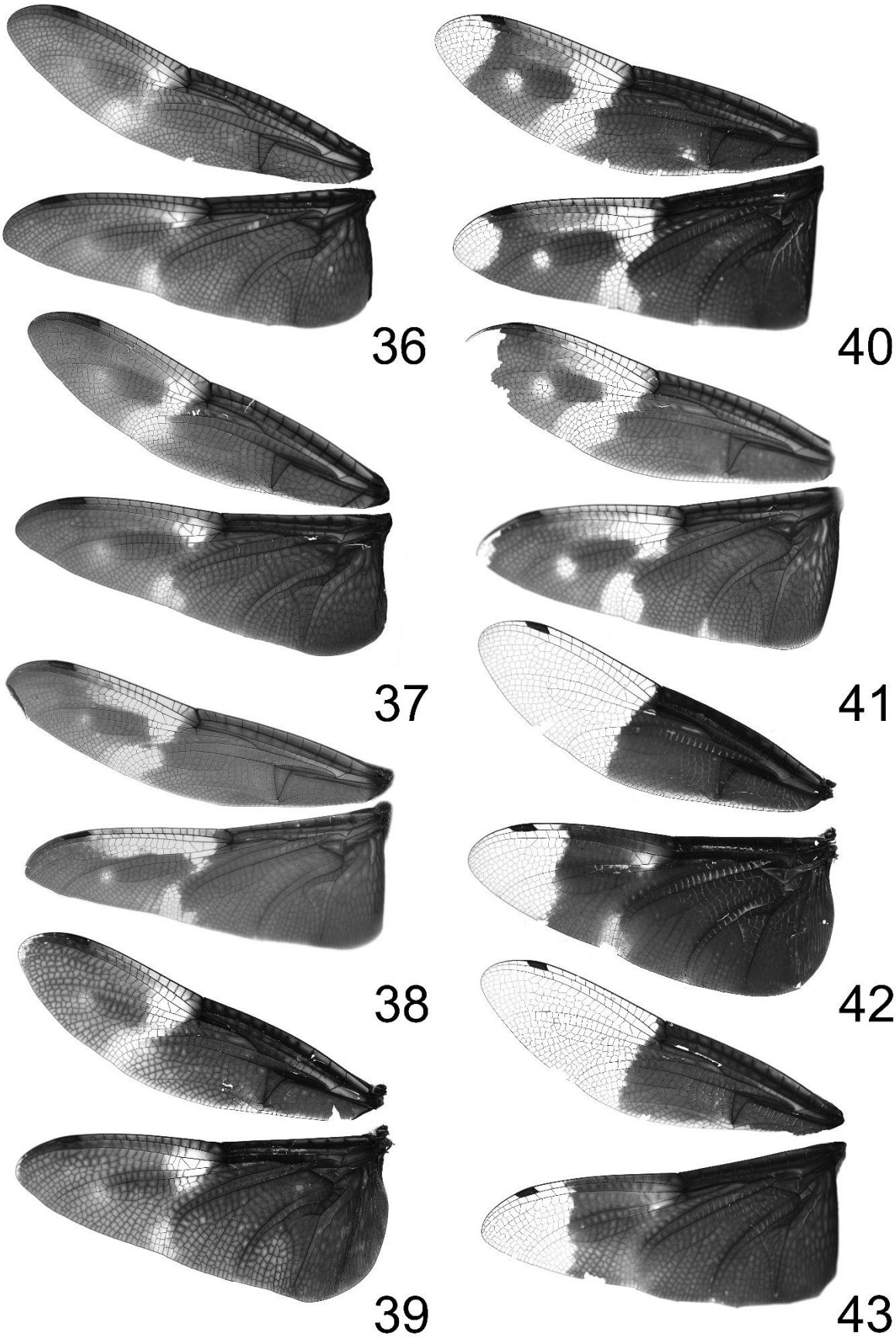
According to Lieftinck (1959), the northern boundary of *R. regia* had never exceeded N19° (Pagan Island) in latitude. However, the nominate subspecies has been reported from southern Taiwan (N22°) in 1996 (Yeh, 1996). This subspecies dispersed quite rapidly in the island from the south northwards (personal observation) and in 2000 was recorded from northern Taiwan (Xindian, New Taipei City, N25°, see specimens examined). Nowadays, it is widely distributed almost all over the island (Fig. 44). This kind of dispersion towards the north has been suggested to be range expansion or shift caused by climatic warming, which has proven to be common for dragonflies (Hichling et al., 2005; Ott, 2010). Similar examples of northward dispersion in Taiwanese dragonflies have also been found in *Neurothemis taiwanensis* Seehausen & Dow, 2016 and *Potamarcha congener* (Rambur, 1842) (Hu & Ma, 2018); the former has rarely been reported from northern Taiwan before 1990 (Matsuki & Lien, 1983, 1989), but is now widely distributed and common on the island (personal observation), with the northeastern boundary of its distributional range even reaching two Japanese islets, *i.e.* Yonaguni and Iriomote islands in the Ryukyu Islands where it has never been recorded before (Ozono et al., 2012).

Rhyothemis regia and *R. phyllis* (Sculzer, 1776) were mutually exclusive in their distributional areas and rarely co-existed in the same local site (Lieftinck, 1953b). The nominate subspecies of *R. phyllis* has been recorded from the Ryukyu Islands since 1981 and subsequently expanded its range northwards into Kyusyu in the south of Japan (Ozono et al., 2012). Recently, *R. r. regia* has also been reported from Yonaguni Island (Kohama, 2021); hence, it is interesting to keep observing how this species will interact with *R. p. phyllis*, while it keeps expanding its range northwards as global climate becomes warmer.



Figures 1–29. Wing patterns in *R. regia* subspp. 1–8, *R. r. regia*; 9–12, *R. r. juliana*; 13 & 14, *R. r. pretiosa*; 15–20, *R. r. exul*; 21–23, *R. r. thisbe*; 24 & 25, *R. r. armstrongi*; 26 & 27, *R. r. chalcoptilon*; 28 & 29, *R. r. uveae*. 1 & 2, males, Sabang; 3, male, Engano; 4, male, Palawan; 5, male, Basilan; 6, male, Amboina; 7, female, Palawan; 8, female, Sabang; 9–12, males, northern New Guinea; 13, male, Ternate; 14, female, Minahassa; 15–17, males, Kei; 18–20, females, Kei; 21, male, Buru; 22, female, Buru; 23, female, Sumba; 24, male, Samoa; 25, females, Samoa; 26, male, Niuafo'ou; 27, female, Niuafo'ou; 28, Wallis, male; 29, female, Wallis. 4, 6, 7, 13, 14, 17, 18, 20, 22 copied from Ris (1912 & 1913), 26-29 from Marinov (2021), the others from Lieftinck (1926, 1942, 1948, & 1959).

Figures 30–35. Female characters of *R. r. regia* (30–32) and *R. fuliginosa* (33–35). a & b, face in front view; c & d, apical abdominal segments in dorsal view; e & f, ditto. in ventral view.



Figures 36–43. Wing patterns of Taiwanese *R. r. regia*. 36–38, males, 39–43, females. 36, Xindian, New Taipei City; 37, Datong, Yilan County; 38, Dawu, Taidong County; 39, Xinyi, Jilong City; 40–41, Neipu, Pingdong County; 42–43, Xinyi, Jilong City.

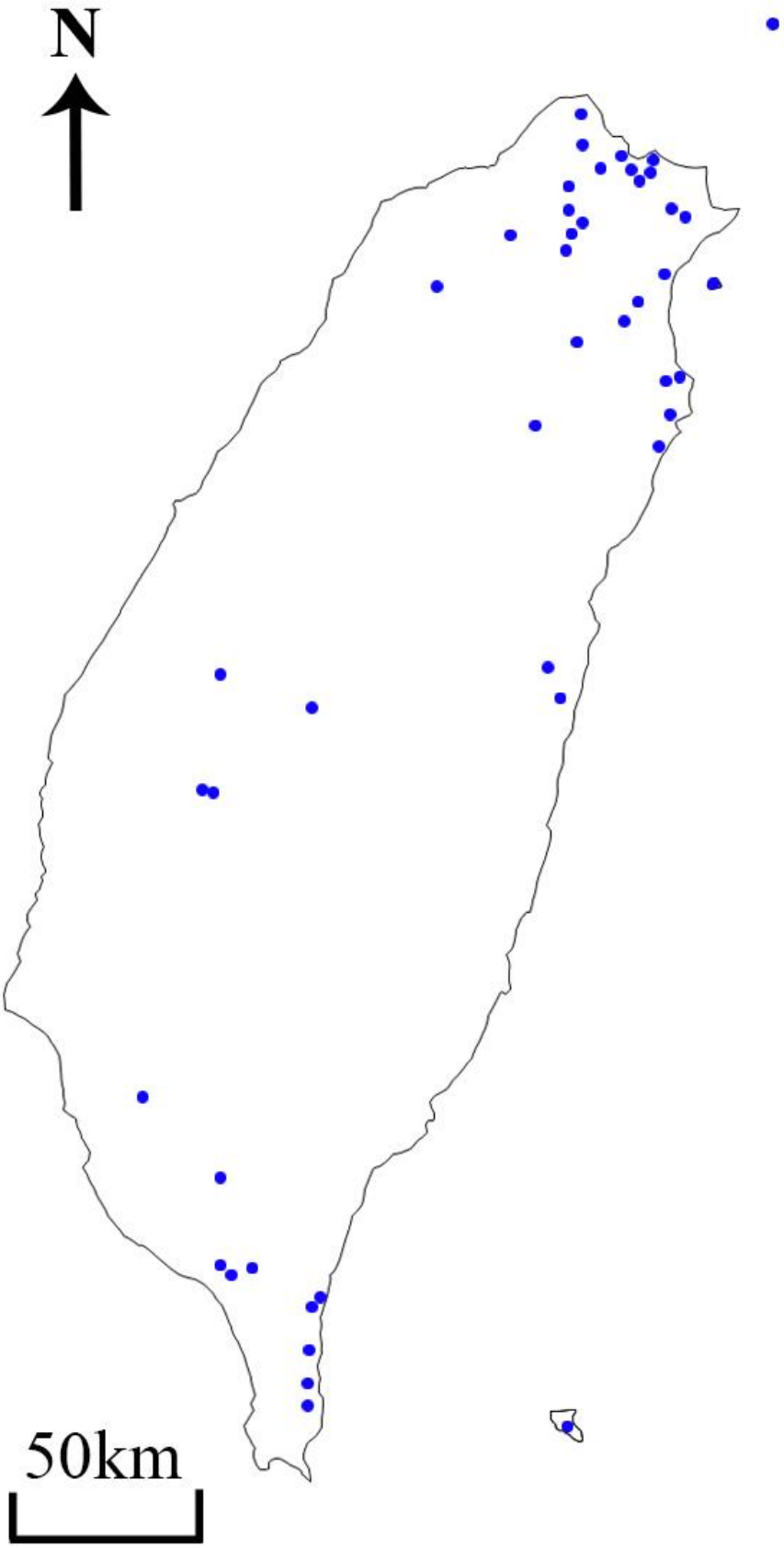


Figure 44. Distributional map of *R. r. regia* in Taiwan before 2015.

Acknowledgments

I sincerely thank Han-Ian Chiou (deceased) who kindly reminded me of the frequent and unusual copulations between male *R. r. regia* and female Taiwanese *R. fuliginosa*; his encouragement has greatly motivated me to solve the issue presented in this study. Milen Marinov is grateful for his helpful comments on *R. r. chalcoptilon* from Samoa. Thanks are due to Lou Chi-Ming for providing distributional data of *R. r. regia* in Taiwan compiled from a database maintained by him. Szu-Lung Chen and I-Lung Lee kindly provide the female specimens of Japanese *R. fuliginosa* at my disposal.

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臺灣產黑翅蜻蜓紀錄的修訂 — 新發現的藍黑蜻蜓雌蟲雌型翅斑（蜻蜓目：蜻蜓科）

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摘要: 臺灣產黑翅蜻蜓 (*Rhyothemis fuliginosa* Selys, 1883) 的身份經澄清為藍黑蜻蜓 (*R. regia regia* (Brauer, 1867)) 的雌型翅斑雌蟲。臺灣藍黑蜻蜓雌型翅斑雌蟲與黑翅蜻蜓雌蟲的差異為臉部顏色較淡，金屬光澤較弱，後唇基前緣內凹較深而明顯，且尾毛較粗。文中經由文獻回顧整理藍黑蜻蜓各亞種已被報導過的翅斑變化以供比較，並附圖說明臺灣藍黑蜻蜓雌蟲翅斑的連續性變異。文末亦說明由於氣候暖化，所導致的藍黑蜻蜓以及其他臺灣蜻蜓科物種分布範圍擴大的例子。

關鍵詞: 多型性的、亞種、氣候暖化、分布範圍擴大

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First Record of Bat Flies (Diptera: Hippoboscoidea) in Masungi Georeserve, Luzon Island, Philippines

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Abstract: This paper presents a preliminary account of bat flies (Diptera: Hippoboscoidea) in Masungi Georeserve, a karst ecotourism landscape in Rizal province, Luzon Island, Philippines. Before this paper, there was no account of the bat fly fauna in the area. Thus, this report represents the first documentation of nycteribiid and streblid bat flies in Masungi Georeserve. Herein, four species representing four genera of bat flies are documented from the rapid biodiversity survey in August 2013. Additional surveys are recommended to further document the bat fly fauna occurring in Masungi Georeserve.

Keywords: Chiroptera, ectoparasite, karst, Nycteribiidae, Streblidae

Masungi Georeserve is a protected geopark and an important ecotourism site in the Rizal province, Luzon Island, Philippines. This area is part of the southern Sierra Madre Mountain range and exhibits a predominantly karst landscape (Aquino & Rivera, 2018). In terms of entomofauna, this area is relatively understudied, especially concerning the parasitic fauna. To date, there is no published account on the bat fly fauna in Masungi Georeserve. Thus, this paper aims to provide the first account of bat flies in the aforementioned area.

Specimens were collected during a rapid faunal survey conducted between August 23-25, 2013. Host specimens were retrieved via mist netting and released immediately upon identification and collection of parasites. Bat fly specimens were preserved in 95% ethanol and later mounted on slides. Specimens were identified following published taxonomic keys (e.g., Cuy 1980a, b). Specimens will be deposited in the National Museum of Natural Science (Taiwan).

***Leptocyclopodia simulans* (Theodor, 1959)**

Material examined. PHILIPPINES: LUZON: On *Ptenochrius jagori*: 2♀♀, 5♂♂ Rizal province, Tanay, Masungi Georeserve, 24-25.VIII.2013, coll. AK Amarga & DAP Fernandez.

***Megastrebla parvior* Maa, 1962**

Material examined. PHILIPPINES: LUZON: On *Eonycteris spelaea*: 1♀, Rizal province, Tanay, Masungi Georeserve, 24.VIII.2013, coll. AK Amarga & DAP Fernandez.

***Nycteribia parvula* Speiser, 1901**

Material examined. PHILIPPINES: LUZON: On *Rhinolophus arcuatus*: 1♀, Rizal province, Tanay, Masungi Georeserve, 24.VIII.2013, coll. AK Amarga & DAP Fernandez.

***Raymondia pseudopagodarum* (Jobling, 1951)**

Material examined. PHILIPPINES: LUZON: On *Rhinolophus arcuatus*: 2♀♀, 1♂ Rizal province, Tanay, Masungi Georeserve, 24.VIII.2013, coll. AK Amarga & DAP Fernandez.

In this paper, two nycterbiids (*Leptocyclopodia simulans* & *Nycteribia parvula*) and two streblids (*Megastrebla parvior* & *Raymondia pseudopagodarum*) are reported (see Fig. 1 for representative specimens). All four species have been documented in karst landscape and surrounding forest ecosystems across different islands in the Philippines (e.g., Amarga et al., 2017; Amarga & Phelps, 2021), but it is the first time these species have been recorded in Masungi Georeserve. Since the collection of these parasites is done during a rapid biodiversity assessment, it is recommended to have follow-up and wider-scale surveys within the georeserve to further document the bats and their ectoparasite faunas in this area. Studying the ecology of these flies can provide insight into the transmission of blood-borne microbes among the same species of bats in a colony and microbial transmission among different species of bats.

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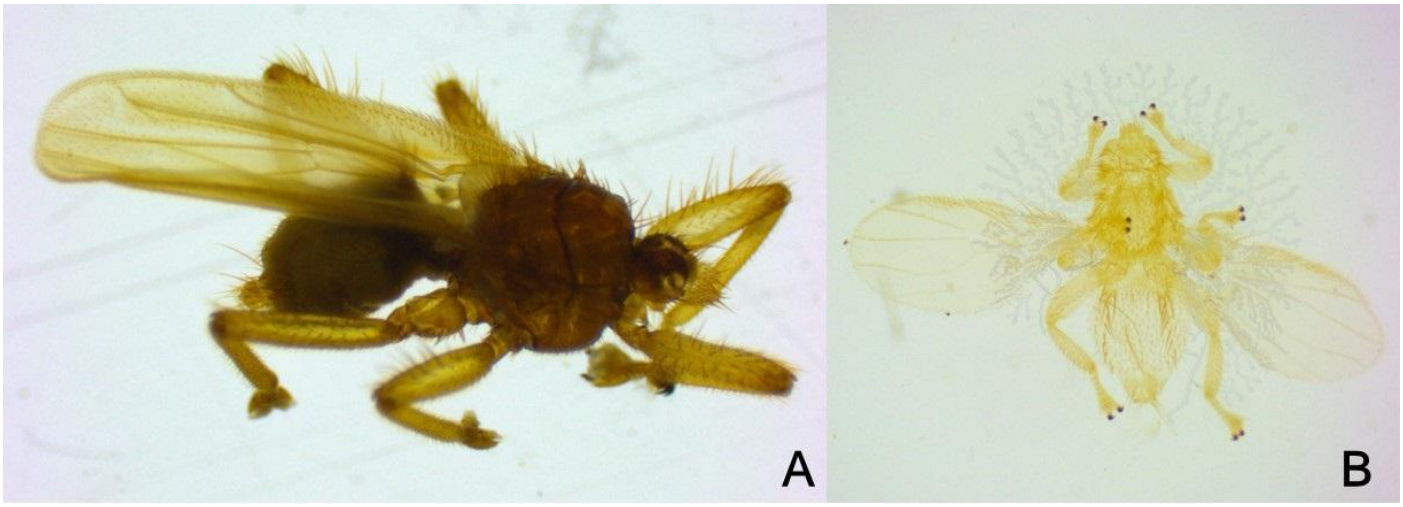

Figure 1. Representative bat fly species found in Masungi Georeserve. (A) *Megastrebla parvior* (♀) and (B) *Raymondia pseudopagodarum* (♂, in slide).

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菲律賓呂宋島馬蘇妮自然保護區的蝠蠅首次紀錄（雙翅目：蠅總科）

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摘要：本文對菲律賓呂宋島黎剎省馬蘇妮自然保護區中喀斯特地形的蝠蠅進行初步描述。此區域過去未曾有任何有關蝠蠅族群的描述。因此，本文為馬蘇妮自然保護區中蛛蠅和蝙蝠蠅的首次紀錄。在 2013 年 8 月的生物多樣性快速調查中，記錄了來自四個不同屬的四種蝠蠅。然而馬蘇妮自然保護區中的蝠蠅相，仍須更進一步的調查。

關鍵詞：翼手目、外寄生蟲、喀斯特、蛛蠅科、蝠蠅科

[科學短訊 Scientific Communication]

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First Record of the Immature Stage of *Agrotis taiwana* Chang, 1991 (Lepidoptera: Noctuidae: Noctuinae: Noctuini)

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Abstract: The larval and pupal morphology of the Taiwanese endemic species *Agrotis taiwana* Chang, 1991 is first described in the present study.

Keywords: Cloud forest, endemic species, East Asia island arcs

According to Fu et al. (2022), three species of the large Noctuidae genus *Agrotis* Ochsenheimer, 1816 are found in Taiwan. Among them, two species, i.e., *Agrotis ipsilon* (Hufnagel, 1766) and *A. segetum* (Denis & Schiffermuller, 1775) are cosmopolitan to the Old World, and the last species, *Agrotis taiwana* Chang, 1991 is endemic to Taiwan and restricted in mid- to high montane regions. The species *A. luzonensis* Wileman & South, 1920, which is endemic to Luzon, the Philippines, was proposed to be closely related to *A. taiwana* (Ronkay et al., 2013). The immature stage, bionomics and phylogenetic relationships of both species are hitherto unknown but may potentially be important for understanding the biogeography of East Asia island arcs. The present study first describes the immature stage of this Taiwanese endemic species.

The larva was kept in plastic rectangle case (65*65*35 mm) under ambient temperature in Xindian, Taipei (ca. 20 m a.s.l.), subsequently the individual pupated and emerged therein. The single specimen of an emerged adult moth was deposited in: NTM – National Taiwan Museum, Taipei. The individual was photographed using a Nikon Z7 digital camera and AF-S Micro Nikkor 60mm F2.8G ED lens with SB5000 flash covering SMDV Speedbox-Flip diffuser. The images were edited in Adobe Photoshop 2023 (Adobe Inc.).

***Agrotis taiwana* Chang, 1991** 臺灣地老虎

(Figs 1–5)

Agrotis taiwana Chang, 1991, *Illustrations of Moths in Taiwan* 5: 61, fig. 39; Fu et al., 2013: 510, pl. 44: 19; Ronkay et al., 2013: 20. pl. 2, figs 3–4; pl. 22, figs 12–19; gen. figs 11–12; Wu et al., 2020: 53.

Material examined. TAIWAN. 1 male, Taichung, Xueshanshenmu, ca. 2500 m, 12. XII. 2022, m, emgd. 10. I. 2023, leg. S. Wu & T.-R. Tseng, SWUBR2022-225, TMIN3833 (NTM)

Description. Final instar (Figs 1–3): body length about 32 mm (n= 1), body shape cylindrical; head red-brown with a pair of wide black stripes on frons closing to clypeus; ground coloration of last two thoracic segments and abdomen indistinguishable, dark ochreous brown, dorsal part of prothorax plate slightly sclerotized and much darker, spiracles black, tubercles dark brown. Pupa (Fig. 5): body length about 22 mm, ground coloration pale red-brown, smooth in appearance; epicranium blunt; antennae extending towards apex of forewing; spiracles black; cremaster bifurcate, straight, apex acute.

The larva in the present study was taken from the concrete wall on a slope covered with two types of mosses (Bryopsida). According to Fu-Chun Yang (pers. comm.), one of them could not be identified and the other belongs to the family Pottiaceae. Since the larva subsequently did not feed on the two plant species and to our best knowledge there is no moss-feeding record in *Agrotis* species, the larva may have been searching on the place for pupation or occurred there accidentally. According to 46 Citizen Science life-photo records and 82 specimen data deposited in Taiwan Moth Information Center (https://twmoth.tesri.gov.tw/, accessed 11 January, 2023), this endemic species is distributed between 1,002 and 3,413 m in altitude, the potential host plants may also be restricted to the mid-altitude area. The main vegetation of larval habitat is mixture of deciduous and evergreen trees, plant species common to the locality are *Acer insulare* var. *caudatifolium*, *Photinia niitakayamensis* (Rosaceae) and *Quercus salicina* (Fagaceae), etc., Further attention is needed to elucidate the corresponding host plant.

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Figures 1–5. The individual of *Agrotis taiwana* Chang, 1991 collected from Xueshanshenmu 2500 m, Taichung. 1. Life photo of final instar in the field; 2. lateral side of the final star; 3. dorsal side of the final instar; 4. emerged male adult; 5. pupa. Photo by Shipher Wu. Scale for figure 2-5= 10 mm.

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臺灣地老虎首次幼生期紀錄（鱗翅目：夜蛾科：夜蛾亞科：夜蛾族）

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摘要: 本研究首次描述了臺灣特有物種臺灣地老虎 (*Agrotis taiwana* Chang, 1991) 的幼蟲和蛹的形態特徵。

關鍵詞: 霧林帶、特有種、東亞島弧

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Notes on a Credible Record of the Flower Chafer *Anthracophora* (*Poecilophilides*) *rusticola* Burmeister, 1842 (Coleoptera: Scarabaeidae: Cetoniinae) in Taiwan

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Abstract: The previous record of *Anthracophora* (*Poecilophilides*) *rusticola* Burmeister, 1842 from Taiwan was based on a doubt record. In this study, we confirm the species distributed in Taiwan based on specimen examination. Simultaneously, the biological information of *A.* (*P.*) *rusticola* also briefly discussed.

Key words: Fauna, Oriental region, Palearctic region, Flower chafer, Taiwan

Anthracophora (*Poecilophilides*) *rusticola* Burmeister, 1842 is widely distributed in the East Palearctic region, e.g. China, Korean Peninsula, Eastern Russia, Japan and Oriental region: Northern Vietnam and Taiwan (Sakai & Fujioka, 2007; Sakai, 2012). Sakai (2012) reported the species from Taiwan for the first time, but did not examine specimens. In this paper, we examined newly collected specimens of *A.* (*P.*) *rusticola* from Taiwan, which confirms the distributional status of the species.

The examined specimens are deposited in the institutions as follows: BHHc-Bin-Hong Ho private collection, Taipei, Taiwan; YCCc-Yi-Chia Chiu private collection, Chiayi, Taiwan; CHLc-Ching-Hsun Lin private collection, Nantou, Taiwan. The supplementary information of labels data was used in square brackets ([]).

***Anthracophora* (*Poecilophilides*) *rusticola* Burmeister, 1842** 紅斑花金龜、褐銹花金龜
(Fig. 1)

Diplognatha rama Bainbridge, 1842: 217.
Porphyronota sinensis Saunders, 1852: 32.

Materials examined. TAIWAN: Taoyuan City: 1♀, 1.V.2016, 復興 [Fusing], 上巴陵 [Shangbalin], by hand, 林敬勛 [C.H. Lin leg.] (CHLc). **Yilan County:** 1♀, Sanxing, Popuwoo (破布烏), 20.VIII.2019, Yu-Hsiang Liu leg., ex. *Koelreuteria elegans* (BHHc). **Chiayi County:** 1♀, 17.VIII.2022, Meishan, Longyan, by bait trap, Y.C. Chiu leg. (YCCc). 1♀, 20.VIII.2022, same data as above (YCCc).

Remarks. *Anthracophora* (*Poecilophilides*) *rusticola* has a unique biology: the larvae are known from several carnivorous, piscivorous, or omnivorous bird nests, e.g. *Pernis apivorus* (Linnaeus), *Ciconia boyciana* Swinhoe, *Phalacrocorax carbo* (Linnaeus) from Japan and *Accipiter soloensis* (Horsfield) from Japan and South Korea (Choi et al., 2008; Koshiyama et al., 2012; Sakai, 2012), moreover, Choi et al. (2017) also reported the life cycle of *A.* (*P.*) *rusticola* in a Korean population. The biological information of *A.* (*P.*) *rusticola* of the Taiwanese population is still unknown. Based on examination of specimens it is known that adults can be collected by baiting traps with rotten fruit. They also feed on the tree sap of *Koelreuteria elegans*.

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Figure 1. Female habitus of *Anthracophora* (*Poecilophilides*) *rusticola* Burmeister, 1842 from Taiwan.

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臺灣產紅斑花金龜的可靠紀錄（鞘翅目：金龜子科：花金龜亞科）

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摘要：紅斑花金龜 (*Anthracophora* (*Poecilophilides*) *rusticola* Burmeister, 1842) 原先在臺灣的分布存疑，本文首次提供了臺灣產紅斑花金龜的可信標本紀錄，確認此種分布於臺灣並簡短討論紅斑花金龜的生物學資訊。

關鍵詞：動物相、東方區、古北區、花金龜、臺灣

臺 灣 研 蟲 誌

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